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ABSTRACT

A 12-week study of two groups of 14 college freshmen music majors was conducted to determine which group demonstrated greater achievement in learning auditory discrimination using computer-assisted instruction (CAI). The method employed was a pre-/post-test experimental design using subjects randomly assigned to a control group or an experimental group after a 3-week period of using CAI. A treatment of specifically defined objectives was administered to the experimental group, while the control group was told to continue to improve. A statistical analysis of the data found that there was a significant gain in music achievement between the pre- and post-tests, but there was no significant difference between the achievement of the experimental group and that of the control group. Attitudinal questions and observations indicated that the general attitude towards CAI was very positive, and a learning styles inventory showed that the information gained would be helpful to the instructor in directing the use of CAI by some students. It was concluded that, although the study showed CAI to be a valuable supplement to student learning of auditory discrimination, different types of objectives and different ways of administering objectives should be considered in future studies. Supporting data and tests and forms used during the study are appended, and an extensive bibliography is provided. (DJR)

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# LEARNING AUDITORY DISCRIMINATION
# WITH COMPUTER-ASSISTED INSTRUCTION:
# A COMPARISON OF TWO DIFFERENT
# PERFORMANCE OBJECTIVES

A Thesis Presented

to the

Graduate Faculty of Music

Eastern New Mexico University

In Partial Fulfillment

of the Requirements

for the Degree

Masters of Music

by

Kurt A. Steinhaus

July 31, 1981

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# LEARNING AUDITORY DISCRIMINATION WITH COMPUTER-ASSISTED INSTRUCTION: A COMPARISON OF TWO DIFFERENT PERFORMANCE OBJECTIVES

Many university music schools conduct courses for the purpose of learning auditory discrimination. One of the major pedagogical problems in these classes is the wide spread in student ability. Individualized instruction, with the aid of computers, has been developed as a possible answer to this problem. The systems developed to teach ear-training have approached computer applications in two different ways. In one approach, the instructor defines minimum standards of achievement. Once the learner has reached these goals all minimum course work has been completed. In another approach, the instructor recommends a defined amount of time to be spent weekly with the computer. The goal is to progress as far and as fast as student's ability allows.

The purpose of this study was to determine which of two groups of fourteen college freshman music majors will demonstrate greater achievement in learning auditory discrimination. The method employed to accomplish this was a pre/post-test experimental design. Following a three week adjustment period using computer-assisted instruction, subjects were randomly assigned to a control or an experimental group. Following the determination of groups and the testing, a treatment consisting of specifically defined objectives was administered to the experimental group. The control group continued with the same procedure followed during the initial three-week adjustment period. The control group's objectives were not specifically defined. They were simply to improve as quickly as possible. Following the application of the treatment, twelve weeks in length, the same test used for pre-testing was administered to all members in the experiment.

A statistical analysis of the data was used to examine the hypotheses. The first hypothesis:

> $H_0$: There is no significant difference between the achievement scores of the pre-test and post-test.

This hypothesis was tested previous to the primary hypothesis; because in an experiment of this nature, a significant improvement in the population should be evinced before a comparison of groups is meaningful. The primary hypothesis:

> $H_0$: There is no significant difference between the achievement scores of the experimental and the control groups.

Results of the analysis showed that there was significant gain in music achievement between the pre-test and the post-test. The primary hypothesis showed no significant difference between the achievement of the experimental group as compared to the control group. The specifically defined objectives assigned to the experimental groups caused no significant change in student achievement.

A descriptive inquiry into the curricula implications of the microcomputer as it pertains to Eastern New Mexico University's music program was also undertaken. Philosophically, the computer was considered to be a resource intended to amplify the skills and time of the instructor. The possibilities of individualizing parts of the instruction were seen to be the primary advantage of computer applications in music education. Curricular implications were discussed, which pertained to advantages, testing, drill, tutorial, problem solving, data analysis, simulation, and courses.

Attitudinal questions and observations were also a part of the study. The general attitude toward computer-assisted instruction was very positive. Student comments on the post-test showed constructive judgments for the improvement of managing a CAI lab and development of instructional courseware.

A learning styles inventory was administered to students during the second week of the experiment. Results from the inventory showed that with some students information gained would be useful to the instructor in directing use of CAI. This study has been an attempt to add to the body of knowledge pertaining to the educational applications of the computer.

In conclusion, the computer-assisted instruction used in this study was shown to be a valuable supplement to student learning of auditory discrimination. The specifically defined objectives developed for the experimental group had no significant effect when compared to the nonspecific objectives of the control group. However, different types of objectives and different ways of administering the objectives need to be considered in further studies.

## CERTIFICATE OF ACCEPTANCE

This Thesis Presented in Partial
Fulfillment of the Requirements
for the Degree
Masters of Music
by
Kurt A. Steinhaus

has been Accepted
by the
Graduate Faculty of Music
Eastern New Mexico University

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July 31, 1981
(Commencement Date)

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# CHAPTER I

## BACKGROUND TO THE STUDY

Many university music schools that have developed computer systems in ear-training courses have approached computer applications in two different ways. In one approach, the instructor defines minimum standards of achievement. Once the learner has reached these goals all minimum course work has been completed. In another approach, the instructor recommends a defined amount of time to be spent weekly with the computer. The goal is to progress as far and as fast as student ability allows. To the best of the researcher's knowledge there has been no major study exclusively comparing these two approaches. Hence, this study addresses the need for a comparison of two different types of performance objectives commonly found in college ear-training courses using computer-assisted instruction.

The primary problem. This study is intended to determine which of two groups of college freshman music majors will demonstrate greater achievement in learning auditory discrimination. The experimental group has a performance objective defined in specific terms; once the minimum level of achievement has been reached, the required computer work has been completed. The control group has a performance objective defined in open terms; to advance as far as possible within the alloted amount of time.

*The first subproblem*. What are the curricular implications of the microcomputer acquired for this research as it pertains to Eastern New Mexico University's music education program?

*The second subproblem*. Through observation of student computer use and pre/post-test questions, can student attitude toward ear-training be shown to improve or deteriorate?

*The third subproblem*. Will the results of the learning styles inventory be helpful to the instructor in directing student use of computer-assisted instruction?

*Need for the study*. Computer-assisted instruction, based on the principles of individualized instruction is still experimental. While it has been established that computer-assisted instruction can produce results, the question of what it does best for whom demands further study.[1]

There is vast potential in the number of functions the computer can perform in music education. Learning how to take full advantage of computer applications entails significant research of teaching and learning strategies. This study, then, is designed to develop one possible step for improving the design of performance objectives employed in computer-assisted ear-training courses. Hofstetter states: "The primary objective of developers of computer-based systems for musical instruction is the improvement of education in music. Student interest and enthusiasm for this new computer-based instructional medium has generated nationwide excitement."[2]

---

[1] W. R. Hullfish and W. Pottebaum, "The Computer as a Teaching Aid," *Music Educator's Journal*, 57:42, January, 1971.

Music educators have become increasingly aware of the need for investigating the uses of technological developments. In the final report of the National Conference on the Uses of Educational Media in the Teaching of Music, Arberg stated the following:

> ...interest in the arts and humanities has never been greater ...This national interest, coupled with the technological revolution through which we are passing, brings its own imperative for the thoughtful consideration and action of music educators.[3]

The Tanglewood Symposium stressed the view that music educators have not effectively applied new technological developments in the learning process. A section of the Tanglewood Declaration urged that computer-assisted instruction (CAI)[4] be directly applied to music study and research.[5]

As stated in a report of the Music Educator's National Conference, the qualified music educator must "welcome and utilize technological, experimental, and exploratory developments in musical composition, teaching procedures and aids, and sound generating devices."[6] If education is to remain dynamic, new methodology must be developed and researched.[7]

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[2] Fred T. Hofstetter, "Foundation, Organization, and Purpose of the National Consortium for Computer-Based Musical Instruction" (paper presented at the Music Educator's National Conference, Atlantic City, New Jersey, March 11, 1976), p. 1.

[3] H. Arberg, Final Report of the National Conference on the Uses of Educational Media in the Teaching of Music. (U. S., Office of Education, No. OE-4-16-021 Washington, D. C. April, 1965), p. 3.

[4] The acronym CAI will be used henceforth.

[5] R. A. Choate, ed. "impact and Potentials of Technology," Documentary Report of the Tanglewood Symposium, (Washington, D. C.: Music Educator's National Conference, 1968), pp. 123-125.

Individualized instruction has been acknowledged as a highly effective means of instruction by scholars, researchers and educators. Under the learning methods of most educational institutions, developing the individual needs of each student was too costly and involved an overwhelming amount of record keeping. Now, with the decreasing costs of microcomputers, individualized instruction is in a period of renaissance.[8]

Statements, from these many diverse sources, evince the need for research and development of computer applications in music. Also important to mention is the marked increase in membership of the National Consortium for Computer-Based Music Instruction (NCCBMI). This organization is a special interest group in the Association for the Development of Computer-Based Instructional Systems. The NCCBMI was formed as a communication network for research and development of computer applications to improve education in music. The growing membership shows an increasing interest in the potential of this emerging technology.

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[6] Teacher Education in Music: Final Report, (Washington, D. C.: Music Educator's National Conference, 1972), p. 5.

[7] Justin C. Baker, The Computer in the School. Fastback Number 58, U. S., Educational Resources Information Center, ERIC Document Ed 107 222, 1975. p. 3.

[8] Patrick Suppes and Max Jerman, "Computer-Assisted Instruction," The Bulletin of the National Association of Secondary School Principals, 54:15, February, 1970.

Studies have shown that with the aid of the computer, students can make higher grades, spend less time completing course requirements, and enhance their own intrinsic joy of learning. Illustrations of these attributes can be seen in many university music schools.

In an article concerning CAI effectiveness in all fields of education, Edwards and others make the following statements:

> It appears that drill and practice is the most consistently effective mode of CAI. Almost all studies of CAI drill and practice have shown it to be effective when compared to traditional classroom instruction.[9]
>
> ...several studies have shown that learning time can be compressed through CAI.
>
> ...all studies that have measured student's and teacher's attitudes toward CAI have found that both groups like CAI, except when there are hardware problems.
>
> Has the effectiveness of CAI been adequately studied? No, a great deal of research on the effectiveness still needs to be done.[10]

These statements present a strong case, asserting the need for more research to determine the most effective use of computer-assisted instruction.

Theoretical principles of the problem. Any study concerned with learning in music must be careful to consider the elements of musical experience. It is understood by most music educators that learning about and experiencing music must come from the three following interrelated directions: 1) the development of cognitive skills such as theory, history, ear-training, and analysis, 2) achievement of physical skills mainly used in the performance of music, and 3) the cultivation of feeling or affective qualities. When combined, these three essential elements make up aesthetic music education. Computer-assisted instruction can be involved with all three elements of musical experience but especially with the development of cognitive skills.[11]

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[9] Judith Edwards and others, "Is CAI Effective?" Association For Educational Data Systems, 7:123, Summer, 1974.

[10] Ibid., p. 124.

For the purposes of this study, learning and cognitive development will be defined as the result of experiences exhibiting a change in behavior. The purpose of the computer is to create an enviornment for the student in which all objectives involved are directed toward providing experiences which will change behavior. The process is individualized instruction through self-pacing and sequential ordering. The instructional material is based upon a diagnostic evaluation of the students' strengths and weaknesses.

Learning auditory discrimination through CAI involves as a first step the concept of stimulus-response. Stimulus-response is the basis of Gagné's classes of learning, the smallest unit of the total learning process. Chaining, another class of learning described by Gagné is the second step of the learning process in computer-assisted instruction. The grouping of a series of stimulus-response units in an order dependent upon each other constitutes a chain. Each individual link in the chain must be performed correctly to elicit a correct response.

The next step is the process of establishing a number of different chains, known as multiple discrimination. This is the third category of learning that applies directly to CAI. The final step of Gagné's conditions of learning that applies to this study is concept learning. This is the all important step that ties information together and makes it meaningful.

---

[11] Raynold Allvin, "Computer-Assisted Music Instruction: Costs," Educational Technology, 11:20, August, 1971.

An example of this step-by-step process as it applies to CAI and this study can be shown in the learning of interval identification. Stimulus-response is the first and most basic step. When an interval is sounded by the computer, the student hears the interval and types an answer into the computer. The sounding of the interval is the stimulus, and the typing of the answer is the response.

Step two is called chaining, which is grouping responses in an order dependent upon each other. An interval is sounded by the computer which sounds like the beginning of the song "Here Comes the Bride." The student then types the interval "perfect fourth" into the computer. This is chaining, because the correct response was dependent upon previously learning the beginning of "Here Comes the Bride."

Step three is the process of learning two or more chains, called multiple discrimination. Hence, if the next interval sounded by the computer is different than a perfect fourth and the student can relate the new interval to another jingle, multiple discrimination has occurred; because more than one chain has been learned.

At this stage of development another phenomenon can occur. This is termed "interference" by Gagné. As each interval or chain is learned, it must be refined to a point in which it can be distinguished from the other intervals or chains. If the chain is not refined fully, interference will occur, thus eliciting an incorrect response. In this example, interference occurs when a student confuses two intervals such as typing the answer perfect fourth when a perfect fifth was sounded by the computer.

The final step, concept learning, is dependent upon each of the three previous steps. If the student can determine whether the interval sounded is dissonant (sound demanding resolution) or consonant (sound of rest or repose), he has achieved concept learning. For example, a student has conceptualized if he hears an interval and thinks it must have been a major seventh, minor second or a tritione bacause it sounded highly dissonant. The student's concept of a highly dissonant interval is made up of the class or group of intervals major seventh, minor second, and tritone.

The four types of learning discussed are stimulus-response, chaining, multiple discrimination and concept learning. These form the basis for learning auditory discrimination with computer-assisted instruction.

The learning involved in CAI can be placed in two classifications: 1) an overt response, one that is observable, and 2) a covert response, one that occurs mentally without exhibiting immediate behavior to show that learning has taken place. These two classifications of Gagne are mentioned because the computer will respond only to overt behavior typed directly into the computer.

Gagné's conditions of learning are an important premise upon which CAI is designed. It is important that each step of the process be completed. One condition can not occur correctly without the previous step occurring correctly.[12] The primary goal is the desired terminal behavior. Pedagogical design must be sensitive to each step of the learning process. These are not, though, the only theories that must be considered.

The actual music instruction falls into two basic areas: 1) a stimulus presentation followed by an anticipated response with corrective feedback, 2) the student is guided to discover, through a heuristic fashion, the principles established as the goals of the instruction. This study will be primarily concerned with the first basic area of instruction, a stimulus followed by a response.

Theoretical foundations of CAI are also derived from behaviorist psychology. Thorndike's theories of behavioral psychology should be considered in a study involving computer instruction. Most important are his theories of "the law of effect" and "the revised law of exercise." Thorndike states that when a modifiable connection between a situation and a response is made and is followed by a satisfying result, the strength of the relationship is increased. He calls this "the law of effect."[13]

Thorndike later developed the "law of exercise," which emphasizes the importance of the results in learning and not mere repetition of stimulus-response connections. As stated by Thorndike:

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[12] R. M. Gagné, The Conditions of Learning (2nd ed.; New York: Holt Rinehart and Winston, 1970), pp. 4-67.

[13] E. Thorndike, The Psychology of Learning (New York: Reachers College, 1913), pp. 27-33.

> Our question is whether the mere repetition of a situation in and of itself causes learning, and in particular, whether the more frequent connections tend, just because they are frequent, to wax in strength at the expense of the less frequent. Our answer is no... ordinarily we reward certain of the connections leading from it and punish others by calling the responses to which they respectively lead right or wrong, or by otherwise favoring or thwarting them.[14]

Thorndike helped establish a theoretical foundation which eventually led to the development of CAI. The influences of his general principles not only supported the concept of auto-instructional devices, but shaped the design of the symbolic computer programming languages used in computer-assisted instruction.

Another researcher that should be mentioned is B. F. Skinner. Important is his theory of operant conditioning, defined as a type of learning whereby the student assumes an active and participative role in the learning situation. The arrangement of this conditioning is such that the student will not receive any reinforcement or reward until the correct response is given. Reinforcement, therefore, depends upon correct responses.[15] The rationale for CAI related to Skinner's theory is that it is advantageous to require the student to respond to questions by an overt act such as typing into the computer. Also, the student is provided with an immediate feedback to determine if the response was correct. According to Skinner, this process of overt response, feedback, and reinforcement, produces a thorough understanding of each question and answer set before moving on.

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[14] E. Thorndike, The Fundamentals of Learning (New York: Macmillan Company, 1932), p. 231.

[15] B. F. Skinner, The Behavior of Organisms: An Experimental Analysis (New York: Appleton-Century, 1938), pp. 113-116.

One last set of theoretical principles, those of Gordon, will be presented as relating to this study. This set of ideas is particularly important because they present the importance of developing auditory discrimination in music education.

Gordon states that an appreciation of music must come from an understanding of music. Understanding does not guarantee appreciation, but it does provide a basis for it. Understanding in music is developed upon an unconscious syntax or order of tones. This ordering is usually but not always, unconscious. The listener uses this syntax to predict what is to come next through a sense of tonality and/or meter. The listener either hears what he expects or is surprised by something not predicted. Tonality, form, meter, timbre, and style are all considered with what was previously heard to make predictions of what is to come next. The series of patterns presented within changing meter and tonality are vitally important.

When a person looks at an object and then closes his eyes, the object can still be mentally seen. This is called visualization. In music a similar experience can happen. A person can mentally imagine a melody without actually hearing the tones sounded aurally. Gordon has coined the term "audiation" to describe this sensation. Audiation is the ability to hear music silently. Thus, in listening, a person is constantly comparing through audiation the music being performed with what has been heard previously. Audiation is important in the performance of music as well as listening. Gordon states that to perform music:

> ...in a meaningful manner, one must be capable of audiating music, for referential and comparative musical purposes, heard

> at a previous time (long-term memory) and while listening to music, one audiates what has just been heard (short-term memory) as a basis for audiating what will be heard. Without audiation, which is not necessarily nor usually a matter of memorization, even repetition and sequence could not exist and there would be no form in music.[16]

This leads to the question, how is audiation developed? One way audiation is developed is by drill and practice that leads the student to learn the ability to notate what is being heard or to hear what has been written - -"to see with the ears and hear with the eyes."[17] This is also described as music literacy, one of the basic elements in the development of student learning in music. The computer is a valuable tool for providing individualized drill and practice of auditory discrimination, thus developing music literacy. Presented in this section has been the theoretical ideas in education determined to be most important in a study of aural development via computer-assisted instruction.

_Definition of terms_. Definitions of specialized terms used in this study are provided as a matter of clarity.

_Audiation_ - occurs when one hears music through recall or creation, the sound not being physically present, and musical meaning is derived from this recall or creation.

_Auditory discrimination_ - the ability to make distinctions between musical tones; to describe what has been heard using musical notation.

---

[16] Edwin E. Gordon, _Learning Sequence and Patterns in Music_ (Chicago: G. I. A. Publications, 1980), p. 2.

[17] Ibid., p. 7.

Author - one who programs and usually designs lessons for computer-assisted instruction.

Behavior - any visible activity displayed by a learner.

Behavioral objective - a statement that specifies skills, knowledge, and/or attitude, with a criterion for evaluation; all to be completed by the end of a learning activity.

Cathode ray tube (CRT) - an electronic vacuum tube, like that of a television set, containing a screen on which information may be displayed.

Computer - a device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes.

Computer-assisted instruction (CAI) - in the broadest use, the comprehensive application of computers in the educational process, including direct instruction, scheduling, problem-solving, educational data processing and evaluation, and instructional management. Related terms are computer-based instruction (CBI), computer-based education (CBE), computer-managed instruction (CMI), and all of these are encompassed in the broad term educational applications of computers (EAC). For the purpose of this study, a more specific interpretation of CAI will be used. Computer-assisted instruction is an active element of the instructional process in which a student and a computer are in direct interaction, with the objective of bringing about a desirable behavior change.

Control group - those students in the experiment with a performance objective defined in open terms, to advance as far as possible in the alloted amount of time.

Data collection - the storing of information such as student performance, which allows analysis of student progress as well as lesson strategy success.

Experimental group - those students in the experiment with a performance objective defined in specific terms, once the minimum level of achievement has been reached, the required computer work has been completed.

Graphics - the generation of displays other than standard letters and mumbers on the computer monitor. For example, the five lines of the staff and clef signs.

Hardware - the physical equipment forming a computer and its peripheral devices.

Individualized instruction - adapting to the needs or special circumstances of each student, rather than the student adapting to a general program.

Input - information or data transferred from an external storage medium to the internal storage of the computer.

Input/output device - a general term for the equipment used to communicate with a computer, and the data involved in the communication.

Interactive - the ability to act upon one another, between the computer and the student, as in a conversation.

Interval - the distance between two tones.

Keyset - the typewriter-like keyboard, used to transmit information into the computer memory.

Language - a system for communicating information between operator and a machine or between machines. Such a system consists of a carefully defined set of characters, rules for combining them into larger units such as expressions, and rules of arrangement to achieve specific meaning.

Magnetic disc - a storage device on which a large amount of information is recorded on the magnetized surface of a rotating disc. A magnetic disc storage system consists of reading and writing heads mounted on a movable arm.

Output - the information transferred from the internal storage of a computer to an external device, such as a magnetic disc.

Peripheral equipment - the auxiliary devices which may be connected to the central computer, e.g. high-speed printer, speakers, and disc drive.

Program - written in a computer language, the complete pedagogic plan for instruction; including feedback, data gathering, processing, and evaluation of inputs. The complete sequence of instructions and routines necessary for interaction.

Software - the programs that run the hardware.

Storage - the saving of software to be obtained and used at a later time. Synonymous with memory.

Storage capacity - the number of elementary pieces of data that can be contained in storage, expressed by the number of characters or bytes.

Terminal - the hardware consisting of a keyset and a display screen.

Time sharing - the use of a computer for two or more purposes during the same overall time interval, accomplished by interspersing component activities in time.

Touch panel - a device on a terminal which allows communication with the central system independent of the terminal keyboard. The device communicates responses by the operator interrupting vertical and horizontal light beams. The corresponding interruption indicates to the system the location of a response.

# CHAPTER II

# REVIEW OF RELATED LITERATURE

The purpose of this chapter is to examine all obtainable information concerning computer-assisted instruction as it relates to the topic under investigation. The material is divided into three main sections: 1) aspects of individualized instruction as it relates to this study, 2) the historical development of computer-assisted instruction, and 3) related research concerning computer-assisted instruction.

Individualized instruction. Computer-assisted instruction is one form of individualized instruction. The basic premise of individualized instruction is that each student is a unique human being who learns in his own particular way and at his own pace. CAI programs of individualized instruction attempt to adapt to the student rather than force the student to adapt to a general program. Although this approach is, to a large extent, the result of recent research and development, the concept of individualized instruction in America can be traced to colonial days. At that time, tutors taught in the home on a one-to-one basis which was most definitely individualized instruction. If this was a good method of instruction, why was it not continued? Finances became a major factor in the move away from this one-to-one instruction.

Individualized instruction decreased after the United States enacted the amendment to the constitution providing education for all children. Affordable methods for mass education had to be developed. These teaching philosophies did include some individualized instruction, but most turned to other methods such as the lecture technique. The learning theories influential in shaping American education, including Pestalozzi, Froebel, Parker and Dewey, did include some ideas of individualized instruction. One early experiment dates from 1908, when William Wirt initiated an educational plan in Gary, Indiana, called the Gary Plan. The Gary Plan encompassed work, study, and play in a twelve month school year. In 1919, another plan was implemented by Carleton Washburn. Under this plan, students learned on an individual basis, guided by their teachers. The risk of failure was greatly reduced because the program was adjusted to the individual student's rate of learning.

Another experiment came closer to individualized instruction than the earlier plans. This was the Dalton Plan which took place in 1920 in Dalton, Massachusetts. Besides enabling the learner to proceed at his individual pace, the student contracted with the teacher for a monthly assignment. The effects of this project are evident today in the use of broad study units encompassing shorter assignments. The Open School movement in England in the 1940's also contributed to the ideas of individualized instruction in America. This movement emphasized a shift of the teacher's role from being the center of attention to the student as the center of attention. The teacher was intended to become a facilitator of the learning process.

There are four general types of individualized programs. One type is called individually diagnosed and prescribed instruction. The instructor selects materials and determines learning objectives; the learner is permitted to learn at his own pace. The second type is self-directed instruction. The learner chooses the materials and determines how to proceed. The instructor determines the structure of the program and sets the educational goals. The third type is personalized instruction programs. The learner establishes his own educational goals. Once the goals are chosen, however, the pupil is required to follow a program established by the instructor and to use specific materials selected by the school. The fourth type is independent study programs. This permits the learner to determine his own learning objectives and achievement methods. In most cases, only students that have previously shown a high learning capability are permitted to enter this fourth type of individualized instruction.

Programs of individualized instruction develop out of a need for improvement of the learning process. The grouping of a large number of students into one mode of learning can often be a deterrent to learning because it is a distortion of their normal environment. Through the use of CAI, students can investigate areas of self-interest and, at the same time, develop important academic skills. Continued emphasis on individuality, aesthetic education, and humanistic values seem to indicate the eventual acceptance of individualized instruction in American education.[1]

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[1] Michael L. Mark, Contemporary Music Education (New York: Schirmer Books, 1978), pp. 174-181.

Historical development of CAI. Although this study considers CAI to be relatively new and revolutionary, the basic form of instruction can be traced back to the Socratic method. Socrates (496-399 B. C.), the Greek sage and teacher, used the simple technique of question and answer whereby his students were to think independently with reason and clarity. CAI in similar ways utilizes the question and answer approach enabling independent thinking on an individual basis.[2]

The year 1907, in Rome, can be identified as the first historically known attempt to utilize a machine for teaching. The machine was made and used by Maria Montessori. Her work with teaching devices eventually led to the concepts of programmed instruction.[3]

During the 1920's, in America, Sidney Pressey used mechanical devices with which students could be asked questions, respond, and receive confirmation as to the accuracy of their responses. The device was designed to free the instructor for the more important thought-stimulating and idea-developing type of teaching. In 1932, Pressey predicted that a coming trend in education would use machines for drilling students in arithmetic and spelling.[4] This prediction has been repeated many times since 1932 and is still being heard today, only the word "machine" has been changed to the word "computer." For example, the President's Science Advisory Committee stated this similar idea: "We predict that, in the future, almost all undergraduates will use computers profitably...it has added a new dimension to education..."[5]

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[2] William Uttal, On Conversational Interaction. Learning and Computer-Based Instruction (New York: Wiley and Sons, 1970), p. 175.

[3] Maria Montessori, The Montessori Method, A. E. Georde, ed., (Philadelphia, Penn,: Lippincott, 1912), p. 29.

[4] A. Lumsdaine and R. Glaser, Teaching Machines and Programmed Learning: A Source Book (Washington, D. C.: National Education Association, 1960), p. 47.

The next stage of development in CAI is rooted in the developments of B. F. Skinner, a Harvard psychologist. In the 1950's, programmed instruction became refined and well known through B. F. Skinner's research. This was coupled with a rash of developments in teaching machines, which met with varying degrees of success. The teaching machines soon began to decrease in number as educators learned that well-prepared lessons in a sample booklet form provided essentially the same learning without the complexities and expense of teaching machines. There was also criticism of the machine's limitations and little student interaction in the instructional process. Because of these criticisms and teacher management difficulties, the teaching machine declined in popularity. The positive aspect of this movement shows that programmed instruction was proven to be an effective mode of instruction.[6,7] Programmed instruction achieved acceptance because it provided some answers to the individualization of learning materials. It was then postulated that the sophisticated computer could widely expand programmed instruction and give it added validity as a teaching method.[8]

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[5] President's Science Advisory Committee, Computers in Higher Education: Report of the Committee to the White House, February 1967 (Washington D. C.: Government Printing Office, 1970), pp. 7-8.

[6] W. Kuhn and R. Allvin, "Computer-Assisted Teaching: A New Approach to Research in Music," Journal of Research in Music Education, 15:310, Fall, 1967.

[7] W. R. Hullfish and W. Pottebaum, "Take on a Digital Assistant," Music Educator's Journal, 57:84, January, 1971.

An essential difference between programmed instruction and computer-assisted instruction is that CAI can adapt and change to the specific needs of the individual student. This is accomplished in an almost infinite variety of ways, such as adjusting the rate of learning to special needs, assigning remedial work if necessary, helping the student decide his rate of learning, providing a continuous and immediate appraisal of learning and progress, and storing student data for later retrieval and analysis.

Computer hardware came into being in 1944, at Harvard University. It was the first operational digital computer. By 1950, twelve computers had become operational in the United States. Ten years later, 6,000 computers were in use, and by 1975, 90,000 machines were scattered about the world.[9]

A dramatic increase in the usefulness of computers was coupled with a decrease in their size and cost. As a result, computers have become faster, more reliable, and less costly every decade they have been in existance. The microcomputer, used in this experiment, has a larger computing capacity than the first computers built and is twenty times more reliable.

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[8] John R. Feldhusen and Michael Exaboo, "A Review of Developments in Computer Assisted Instruction," Educational Technology, 9:74, April, 1969.

[9] Ned C. Deihl, Development and Evaluation of Computer-Assisted Instruction in Instrumental Music, (U. S., Office of Education, Bureau of Research, University Park, Pennsylviania: Pennsylvania State University, No. 7-0760), p. 23.

At Dartmouth, Kemeny developed programs in 1958 that provided the computer world with the BASIC computer language.[10] This is the primary language used in the computer programs of this study.[11]

Early computerized teaching began at the IBM Watson Research Center in 1958. Another early trial was reported by Anderson and Brainerd in 1959.[12] Also in 1959, a very important CAI project began at the University of Illinois with support from Control Data Corporation and the National Science Foundation. This project is known by its acronym PLATO.[13] PLATO II followed in 1962 with two terminals, and PLATO III in 1964 with twenty. Presently, PLATO IV is being used and developed in all fields with two major concerns: 1) researching the instructional potential of the computer, and 2) designing of an economical and educationally viable system. It is interesting to note that the hourly cost of this system has gone down while the general cost of education has shown a marked increase. The people involved with PLATO expect the hourly cost to continue decreasing. At the University of Deleware Music Department, eight PLATO terminals cost $3,850 per terminal for one year of use in 1979. This is an annual total of $30,800 with approximately 16,000 hours of instruction time making the average hourly cost of instruction $1.93. With further developments, the cost is estimated to be below $1.10 per hour by 1985.[14] The PLATO system is one large centralized computer housed at the University of Illinois. Terminals connected by phone line to the main computers serve many different universities. The computer terminals have a unique type of visual display developed especially for CAI including touch panels. The PLATO system also allows teachers to design their own programs of instruction. Improving the productivity of teachers is the main goal of PLATO, rather than replacing the teacher as the center of instruction. The process for selecting and developing a program of instruction on PLATO is very similar to methods used in traditional courses. First, the scope and lesson content are determined. Then, the material is put in a logical sequence for instruction. The technical and mechanical aspects are tested for a minimum of three semesters. Evaluation of learning is conducted in the same manner as traditional courses. Once found to be useful, the program of instruction is made available to universities employing terminals all over the United States.

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[10] BASIC, an acronym, Beginners All-Purpose Symbolic Instruction Code.

[11] John J. Hirschbuhl, "Hardware Considerations for Computer Based Education in the 1980's," Journal of Research and Development in Education, 4:42, Fall, 1980.

[12] F. B. Baker, "Computer-Based Instructional Management Systems: A First Look," Review of Educational Research, 41:51, 1971.

[13] PLATO, Programmed Logic for Automated Teaching Operations.

Another project started just after PLATO was created is the IBM 1500 Instructional System. It was an attempt to adapt the traditional means and materials of music instruction to a computer. The goal was to demonstrate, on a small scale, some of the technological potentials

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[14] Fred T. Hofstetter, "Instructional Design and Curricular Impact of Computer-Based Music Education," Educational Technology 21:44, April, 1978.

of the computer. The system contains an IBM 1130 computer, audio playback and recording terminals, cathode ray tubes with light pens, and keysets. The computer language used is Coursewriter II, the IBM instructional programming language. The subject area of basic musicianship was divided into four segments: 1) ear-training, 2) music notation using a keyboard image, 3) elementary analysis, and 4) rhythmic discrimination. The ear-training experiments began with melodic dictation and progressed to elementary harmonic dictation. Additional practice was available to those needing it, while the others went on to more difficult material. The instructional sequence began with two pitches being sounded simultaneously. There was also a visual display of the first pitch. The student was asked whether the second pitch was higher or lower than the first. To answer, the student points a light pen to places on the screen known as targets. One target signified a high pitch and the other target a lower pitch. Both targets then disappeared and the second note was displayed on the screen. This is followed by sounding the original pair of tones. Thus the comparison of student response with the original audio assumed the function of either reinforcement of the correct response or correction. As the difficulty level increased, more targets were provided. Eventually the whole staff would be displayed as a target and the student could specify and hear chosen pitches.

The computer was programmed to identify correct responses and several anticipated wrong responses. Any other response would be termed "unidentified." A correct response would lead to the next problem. Wrong answers that were anticipated in the computer program would lead to additional explanation and drill.[15]

Another important CAI design was developed at York University: The Interactive Music Project. The computer used was a PDP-10. This project showed the excellent potential of CAI as a tool for developing musical awarneness in children. The major component is a music box which generates musical tones by computer control. After a short acquaintance with the system, musical ideas known as "recipes" can be composed by musicians, non-musicians, adults or children. Transposition of a melody or pitch becomes as easy as the touch of a button. This system is intended to be used in conjunction with other musical activities such as body sounds, synthesizers, and instruments. The music from composers John Paynter and Carl Orff makes use of constructive musical activities that would go along well with this project. "Even the most reticent novice finds it hard to resist trying out his or her own ideas on such a system, assembling or decomposing familiar tunes, adding new rhythms, even building chords or canon."[16]

A different system, designed to be decentralized and built around small computers is TICCIT.[17] The computers used are not as small as the microcomputer but much smaller than the PDP-10 used in the Interactive Music Project. TICCIT features self-contained packages of hardware, operating programs, and course materials. Student motivation and interest is said to increase because of humor, cartoons, and other touches of fun in the learning process. Student attitude in TICCIT is assumed to be much more positive, because he or she has control over the learning process. The teacher is intended either to be eliminated or to function as a diagnostician. A team of specialists design, pre-test, and program the computer in an effort to demonstrate that an industrial approach can replace the teacher as the source of instructional material.[18] This project is important to mention because of its unique philosophy concerning the replacement of the teacher's major role. Most computer projects in education treat the computer as an aid or supplement to the present program.

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[15] Raynold Allvin, "Computer-Assisted Music Instruction: A Look At the Potential," Journal of Research in Music Education, 19: 139, Summer, 1971.

[16] S. Beckwith, "The Well-Tempered Computer (Interactive Music Project)," Music Educator's Journal, 62:34, March, 1976.

[17] TICCIT, Time-shared, Interactive, Computer-Controlled Information Television.

A very important ear-training system called GUIDO was developed at the University of Delaware.[19] Results show students scoring a letter-grade higher with computer-assisted instruction. GUIDO is named after the eleventh century monk and music educator. The curriculum contains aural drill-and-practice lessons in intervals, melody, harmony, rhythm, and chord qualities. The GUIDO system has shown best operation on the PLATO network, because of the touch-sensitive display screen.

The factors contributing to the growth of computer-assisted instruction are as follows: 1) the need for the individualization of instruction, 2) a continued interest in programmed instruction, 3) federal aid to research projects conducted through colleges and universities, specifically, the Elementary and Secondary Education Act of 1965, the National Science Foundation, and the Bureau of Research of the Office of Education,[20] 4) a strong movement in education for improvement and accountability, and 5) the surge of technological development in microcomputers, allowing for the investment of music CAI systems in many universities and private homes. Before the microcomputer was marketed, computer-assisted instruction was considered by most universities to be too expensive.

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[18] Allen L. Hammond, "Computer-Assisted Instruction: Two Major Demonstrations," Science, 176:110-11, June 9, 1972.

[19] GUIDO, Graded Units for Interactive Dictation Operations.

This brief history of CAI has covered a few of the major projects that contributed to important developments. There are a great number of other CAI projects in process all over the United States. These can be classified in a variety of ways. One type of classification covers the functions performed by the computer in CAI: 1) test scoring, 2) diagnosing, 3) prescribing, and 4) reporting. There are two major types of computer hardware. One type is the large time-sharing systems which are used in the PLATO project. These have a large memory and seem to offer virtually infinite capability. However, considerable modification of software and hardware development must take place before musical tones can be a part of the CAI. The initial cost for a large system is considerable; there are line charges and computer time charges. The second type has had rapid developments in the last five years. Increased power and memory of these so-called "micro" systems have blurred the differences between "minis" and "micros." For example, in the early

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[20] R. C. Atkinson and H. A. Wilson, "Computer-Assisted Instruction," Science, 162:73, October 4, 1968.

1970's a "mini" system of considerable memory could be purchased for about 25,000 dollars with about 2,000 dollars worth of peripheral equipment (interfaced organ or other sound-generation unit), and a great deal of software preparation. Today, "micro" systems with pre-packaged software are available for about ten percent of previous costs for "mini" systems.[21]

The two types of instructional philosophies are: 1) the computer instruction is developed to replace the teacher or the teacher's role is managerial, and 2) the computer instruction is used as a supplement to other classroom procedures. The historical development of CAI is important to any person about to embark in CAI research. Without a knowledge of what has been accomplished, the researcher could fall victim to conducting a futile exercise. The materials presented in this report are considered to be the most important post and present developments in computer-assisted instruction as it pertains to this study.

Review of related research. A moderate amount of studies relating to computer applications in music education have been conducted. The one study that relates closest to this experiment was reported by Hofstetter, entitled "Evaluation of a Competency-Based Approach to Teaching Aural Interval Identification." The study was conducted on the computer-based ear-training system called GUIDO which was developed through the University of Delaware's PLATO project. The population was twenty-four freshman music majors, all of whom received the same course of instruction during the first semester. The first semester of ear-training included two hours per week of class time devoted to sightsinging, rhythm training, concept development, and two hours per week spent practicing dictation exercises with the GUIDO system. Identification of ascending melodic intervals was the primary skill learned during the first semester.

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[21] Letter from Dr. Warren E. Hultbury, Professor of Music, Crane School of Music, Fegruary 1, 1981.

The first semester culminated with an achievement test covering ascending, descending, mixed ascending, mixed descending, and harmonic intervals. This test was used to rank the students from 1 (highest) to 24 (lowest). Odd-numbered students were assigned to a control group that continued learning intervals by the same sequential methods used during the first semester. Even-numbered students were assigned to an experimental group that learned intervals according to the competency-based approach.

On the basis of a t-test applied to the pre-test, there were no significant differences between the control and the experimental groups. Students in the control group were required to do at least 50 intervals in each unit, with no competency level defined. For the students in the experimental group, a competency level of ninety percent was defined with a required response time of four seconds.

At the end of the second semester, when all of the students had completed the ear-training program, the same test used at the beginning of the experiment was again administered. The competency-based experimental group received significantly higher grades than the sequential control group. Through a comparative analysis of learning styles, it was determined that the competency-based approach led to a much better use of student time than did the sequential approach. The competency-based group spent less time on the beginning units and more time on the difficult units, whereas student time in the sequential group was more evenly distributed among all of the interval units.

A very important aspect is the attitudinal part of the study. The competency-based students reported a much higher level of frustration than did the sequential control students. Seventy-five percent of the competency-based students agreed that they were frequently frustrated. Only twenty-five percent of the sequential students admitted frustration. Essay answers in the attitudinal section of the post-test revealed that the source of the competency-based student frustration was the requirement of correctly answering twenty-three out of twenty-six harmonic intervals. Sixty-six percent of the competency-based students agreed that time was spent just trying to get through the material rather than trying to learn, whereas none of the students of the sequential control group stated this feeling.

Results of this study show two important conclusions: 1) this particular approach of competency-based teaching leads to significantly higher achievement scores on certain interval types than the sequential approach, and 2) steps should be taken to reduce the frustration level displayed by the students using the competency-based approach.[22]

Early research in CAI. One of the early in-depth research projects in CAI was that of Kuhn and Allvin. Their initial efforts involved the interfacing of a pitch-extractor device with an IBM 1620 computer. The primary objective of the research was to study the interaction between student and machine. Findings indicated that students adapted to the machine early in the program and did not question the reliability of the pitch-extractor device. The subjects reported increased awareness of pitch as a result of the training.[23]

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[22] Fred T. Hofstetter, "Evaluation of a Competency-Based Approach to Teaching Aural Interval Identification," Journal of Research in Music Education, 28:201-213, Fall, 1980.

Deihl and Radocy studied a CAI course for teaching instrumental musicianship which concentrated on aural concepts in articulation, phrasing, and rhythm. The students were to make comparisons of their own performances with pre-recorded models by means of a prototype instant-comparison tape recorder. The course was administered to fourteen clarinetists of varying ability for eight weeks. Results indicate that CAI does offer potential for music education and research in the learning of music.[24,25]

In a subsequent study, Deihl and Beigler expanded the program to include instruction for all wind instruments with treble-clef music. Results of twenty-five subjects who took the revised program were evaluated with criterion-referenced tests. Gain scores were significant with almost all of the subjects reaching the established criterion level for both listening and performance.[26]

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[23] W. Kuhn and R. Allvin, "Computer-Assisted Teaching: A New Approach to Research in Music," Council for Research in Music Education, 11:9-13, Fall, 1967.

[24] Ned C. Deihl and Rudolf E. Radocy, "Teaching Musicianship Via Computer-Assisted Instruction," Education Technology, 11:23-4, August, 1971.

[25] Ned C. Deihl, "Computer-Assisted Instruction and Instrumental Music: Implications for Teaching and Research," Journal of Research in Music Education, 19:299-306, Summer, 1971.

The objective of a sutdy conducted by Moore was to compare linear and branching formats of programmed instruction in music fundamentals. Little difference in achievement or retention was found as a result of the format employed.[27]

Saul's research showed the computer to be an effective tool for simulation and test development in the education of music teachers. This developmental research was conducted at the Eastman School of Music.[28,29]

Cattaneo reported that computer-assisted instruction was more beneficial to middle- and lower-achievement students. He stated that the individualized tutorial-drill instruction provided by computer based lessons had a positive effect on attitudes as well as achievement.[30]

Participants' performance in computer-assisted ear-training as compared with musical background and attitude toward CAI was studied at

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[26] Ned C. Deihl and Ray H. Ziegler, "Evaluation of a CAI Program In Articulation, Phrasing, and Rhythm for Intermediate Instrumentalists," Council for Research in Music Education, 31:1-11, Winter, 1973.

[27] David Alvin Moore, "An Experimental Study to Compare Linear and Branching Formats of Programmed Instruction for Learning Music Fundamentals" (PhD dissertation, University of Oklahoma, 1976).

[28] J. N. Saul, reviewed by C. Boody, "Critique: Three Applications of the Computer in the Education of Music Teachers," Council for Research in Music Education Bulletin, 56:39-43, Fall, 1978.

[29] T. N. Saul, "Three Applications of the Computer in the Education of Music Teachers," Dissertation Abstracts International, 37:1867A-8A, October, 1976.

[30] E. R. Cattaneo, "Who Does CAI Help Most?," Data Processing for Education, 17:1-11, May, 1973.

Stanford University. Although the data related to this study were conclusive, the evaluation of the total effect of CAI on learning did not seem to be intended.[31]

Hullfish has shown that students show greater achievement when the CAI is sensitive to the history of each student's responses. The computer program used two different strategies to determine the order of presentation to individual students. One method was determined by the response history of the student, while the other responded only to certain key questions. No significant difference in attitude was found between the groups. This study has several basic strengths. A valid comparison of two methods of presenting identical musical material to similar students through the same medium was made. Second, empirical evidence was gathered to show that significantly greater achievement results from the programming strategy which takes greater account of student's prior knowledge and responses.[32]

Sponsored through the United States Office of Education a study was undertaken to determine the feasibility of individualized computer-assisted instruction in keyboard experience at the elementary school level. The study was intended to evaluate the cost-effectiveness of CAI. This system was found to be technically and educationally feasible, but not economically feasible. However, the cost analysis does not apply to present costs of CAI. The researchers did note that the children participating in the testing made remarkably fast improvement through the lessons.[33]

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[31] Rebecca Herrold, The Development and Trial of a Computer Managed Test of Music Fundamentals, U. S., Educational Resources Information Center, ERIC Document ED 171 312, 1977.

[32] W. R. Hullfish, "A Comparison of Two Computer Assisted Instructional Programs in Music Theory," Journal of Research in Music Education, 20:354-61, Fall, 1972.

*The status of CAI development*. In 1975 Jones conducted an attitudinal study to determine the status of music computer-assisted instruction in higher education. Five specific conclusions were revealed. With a total of 434 institutions responding, he found that: 1) few music educators were involved in teaching by computer systems, 2) few students were involved with computer-assisted instruction as learners, 3) few music educators and music graduate students were involved in research in computer-assisted instruction, 4) few quality course materials were available, and 5) no formal mechanism exists for sharing computer-assisted efforts in music.[34]

As the Jones study was conducted in 1975, results of a similar study today would probably be quite different. For instance, conclusion number five states there is no organized system for sharing CAI information. To date, there are two formal sources for exchange of CAI information.

One source is the National Consortium for Computer-Based Musical Instruction (NCCBMI). The purposes of NCCBMI are as follows: 1) to provide a forum for the exchange of ideas among developers and users of computer-based systems, 2) to establish and maintain a library of music software, 3) to reduce redundant effort among developers, and 4) to provide consultation for new users of computer-based musical instruction.[35] The National Consortium for Computer-Based Musical Instruction participates in functions of the Association for the Development of Computer-Based Instructional Systems (ADCIS). This is an international organization representing educational institutions in all fields of knowledge involved with computer applications.

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[33] William P. Kent and others, *Feasability of Computer-Assisted Elementary Keyboard Music Instruction*, U. S., Educational Resources Information Center, ERIC Document ED 038 039, March, 1970.

[34] Morgan Jones, "Computer-Assisted Instruction in Music: A Survey With Attendant Recommendations" (PhD dissertation, Northwestern University, 1975).

A second source for exchange of information is the Index to Computer Based Instruction. Organized by subject, this index lists the program category, program name, author, source, description and other pertinent details concerning the computer software. This is a valuable source to any author of educational computer programs.

Developmental research projects. In a developmental study conducted by Allvin, students were taught sight-singing with a computer-assisted system. Results of the experiment showed that students could identify melodic sequences without depending upon a tonal center. One inference from this study is that the automated music learning system may facilitate the learning of contemporary music.[36]

One of the more important developmental studies was conducted at the University of Georgia. Placek designed a CAI lesson for teaching rhythmic perception to students preparing to be elementary teachers. The study began with the selection and statement of behavioral objectives. The software contained provisions for anticipated wrong answers with subroutines providing supplementary explanations. Students participating in the study reacted positively to the experience. They valued the personalized responses built into the software and the feedback given in a relatively confidential situation. They also expressed approval of the audio-visual potential of the system including the capability of the computer to define a task, demand input, and quickly judge the response. In his study, Placek concluded that computer-assisted instruction in music was feasible and that music educators should become involved with CAI.

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[35] Fred T. Hofstetter, "Foundation, Organization, and Purpose of the National Consortium for Computer-Based Musical Instruction" (paper presented at the Music Educator's National Conference in Atlantic City, New Jersey, March 11, 1976).

[36] Raynold Allvin, "Computer-Assisted Music Instruction: A Look at the Potential," Journal of Research in Music Education, 19:131-43, Summer, 1971.

In a study of the feasibility of computer-assisted instruction for instrumental music education, Peters concluded that the computer is capable of evaluating pitch and rhythm accuracy in trumpet performance. One other conclusion was that students participating in the study were motivated to achieve correct response judgments from the computer.[37]

Hofstetter's many developmental studies were conducted at the University of Delaware through the PLATO system. In one study, achievement of eighteen freshman music majors in the GUIDO chord quality program was studied. The objectives were twofold: 1) recognition of closed position chord quality, and 2) recognition of open position chord quality. The computer lessons were designed to play chords on a synthesizer and pose questions to the students concerning what they just heard. The top of the display screen contains two columns of touch-sensitive boxes. The right boxes require the student to indicate whether the chord in question was in root position, first inversion, or second inversion. Using the boxes on the left, students indicated whether the chord was major, minor, diminished or augmented. Also provided were four additional touch-sensitive boxes at the bottom for control of the synthesizer. The student could request the chord to be sounded again, in succession or simultaneously. A staff in the middle of the display illustrated the notated chords after the student's correct response. The first semester dealt with open position chords while the second semester covered mainly closed position chords. The results of the study showed significant learning gains during both semesters. Also, it was shown that there was transfer of knowledge gained in open position chords the first semester, which led to improved scores of closed position chords the second semester.[38]

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[37] G. David Peters, "Feasibility of Computer-Assisted Instruction for Instrumental Music Education" (EdD dissertation, University of Illinois, 1974).

One very interesting study was conducted at Stanford University by Killam, Lorton, and Schubert. Intervals were selected at random, and played by a computer controlled organ. Students were asked to identify the interval. Every correct and incorrect response was recorded. Results of this study show that some previously accepted learning beliefs may be myths. For example, it has been stated that if intervals are played slower, they are easier to identify. Resluts of this study show no significant difference in student performance when the intervals were played for .1 second as compared with .2 second. The average correct recognition was seventy-six percent when the intervals were played for .1 second while the average correct recognition for .2 second was seventy-seven percent. Table one shows the most frequently used wrong answers vary as a function of mode of presentation. For example, the tritone sounded simultaneously was confused with the minor third and major seventh; but ascending and descending the tritone was confused with the perfect fourth (Table One).[39]

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[38] Fred T. Hofstetter, "Computer-Based Recognition of Perceptual Patterns in Chord Quality Dictation Exercises," Journal of Research In Music Education, 28:83-91, Summer, 1980.

Research comparing CAI to other types of instruction. A study by Vaughn was designed to study CAI learning rates as compared to a traditional teacher/learner method of instruction in basic musicianship. Conclusions state that: 1) computer-assisted instruction was a better medium than the traditional classroom for the the teaching of ear-training skills, 2) a significant growth of achievement was found in all areas of CAI, melodic, harmonic, and rhythmic, 3) CAI saved the student a considerable amount of time, and 4) the attitude of students revealed a willingnes to experiment with alternative methods of instruction.[40]

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[39] Rosemary Killam, Paul Lorton, and E. Schubert, "Interval Recognition: A Study of Student Accuracy of Identification of Harmonic and Melodic Intervals," Journal of Music Theory, 19:212-234. 1975.

[40] A. C. Vaughn, "A Study of the Contrast Between Computer-Assisted Instruction and the Traditional Teacher/Learner Method of Instruction" (PhD dissertation, Oregon State University, 1978).

Table 1. Confusion matrix summary for modes of presentation in the Stanford study of interval recognition.

| | Most Frequently Wrong Answers | | |
|---|---|---|---|
| Stimulus | Simultaneous | Ascending | Descending |
| m2 | M2 | M2 | M2 |
| M2 | m2 | m3 | m2 |
| m3 | M3 | M3 | M3 |
| M3 | m3 | m3 | m3 |
| P4 | M3 & P5 | P5 | P5 |
| T | m3 & M7 | P4 | P4 |
| P5 | P4 | P4 | P4 |
| m6 | P4 | P4 | M6 |
| M6 | m6 | m7 | m6 |
| m7 | M7 | M7 & M6 | M7 |
| M7 | T | m7 | m7 |
| P8 | M7 | M7 | P5 |

M symbolizes major

m symbolizes minor

P symbolizes perfect

T symbolizes tritone

The numbers symbolize intervals

Research at North Texas State University compared one section of ear-training using the computer one-half hour per week, while the other section did not use CAI. By mid-term, the class using CAI had a median grade of twenty points higher than that of the control group.[41]

A study entitled "The Efficacy of Computer-Assisted Instruction With Traditional Teacher-Taught and Self-Taught Methods of Teaching Beginning Music Theory," was conducted by Cooper. Results demonstrate students learned equally well with CAI, traditional, and self-taught methods of instruction.[42]

In another comparitive study, Hofstetter found that CAI could make a significant impact on student achievement in ear-training. The second semester, the class was randomly divided into two groups, one group was assigned to an experimental GUIDO group, and one assigned to a control tape laboratory group. An average of two hours per week was spent practicing harmonic dictation. Students in the GUIDO group scored higher than students in the tape laboratory group.[43]

Another study which is important to mention was conducted by Feldt, "Abstract, Music Teacher Classroom Technique Versus Computer-

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[41] Rosemary N. Killam, "AMUS: The Computer in Music Instruction" (paper presented at the Proceedings, Texas Music Educator's Association Conference, Fort Worth, TX February 8, 1979).

[42] R. M. Cooper, "The Efficacy of Computer-Assisted Instruction Compared With Traditional Teacher-Taught and Self-Taught Methods of Teaching Beginning Music Theory," Dissertation Abstracts International, 36:5623A-4A, March, 1976.

[43] Fred T. Hofstetter, "GUIDO: An Interactive Computer-Based System for Improvement of Instruction and Research in Ear-Training," Journal of Computer-Based Instruction, 1:100-6, February, 1975.

Assisted Instruction." The objectives of this study were to show: 1) how computer teaching compares to standard teaching in terms of achievement gain or loss, 2) how computer teaching affects students with a high initial achievement score, 3) how computer teaching affects students with a low initial achievement score, and 4) a comparison of achievement and time spent in the two modes of instruction. The study groups were seventh grade General Music class students from Kansas City, Missouri. The control group contained twenty students while the experimental group had seventeen, all randomly selected. Concepts to be learned were the staff, clef signs, letter names of lines and spaces, ledger lines, notes, rests, accidentals, time signatures and a few other basic fundamentals of music theory. Based on a t-test, the results showed that CAI is an effective teaching tool; CAI students learned in thirty percent less time, and CAI students with a low initial achievement scores gained significantly. Based on the E-score, conclusions were slightly different. Superior test score students learned better under teacher classroom techniques, while low test score students learned better with CAI.[44]

In many subjects, computer-applications as a supplement to traditional instruction have been shown to be more effective than instruction without CAI. Suppes, using third grade students in California and Mississippi, showed 2.28 and 2.03, respectively, grade levels of improvement in one year. Another study by Fletcher and

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[44] J. R. Von Feldt, "Computer-Assisted Instruction in the Public School General Music Class: A Comparitive Study, (PhD dissertation, University of Missouri-Kansas City, 1971).

Atkinson found that students who received one year of supplementary CAI instruction in reading scored an average of .6 grade levels higher than students receiving normal instruction.[45]

Although there is room for much more research related to music theory and CAI, the positive effectiveness of this instructional aid is a reasonably well-established fact. CAI in other fields has also been established as a viable teaching tool.[46] Vinsonhaler and Bass suggest that there seems to be little doubt that CAI plus traditional teacher/learner instruction is usually more effective than traditional instruction alone.[47] Many studies have shown that knowledge has been gained with a variety of different students, materials, and procedures. A consistent finding is that students learn equally well or better using CAI compared with other methods of instruction.

When drawing conclusions from these studies, there are a few important statements that must be considered. First, the results of any study in learning is highly dependent upon the quality of the instruction. If the instructional software is not well designed, results will be much different than studies with well designed instructional software. Second, as shown by the recent market boom of electronic devices, this kind of technology is very appealing. Just the novelty of using a computer for the first time could greatly change the results of an experiment. As stated by Seidel "...it is required that the alternative educational innovations not be in a preliminary or pilot stage of development. If computer-based systems are involved, they should, at a minimum, be tested and stable prototypes."[48] It is not proper scientific method to compare a type of instruction that is not fully operational against a method of instruction that has been thoroughly tested and operational for some time.

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[45] Judith Edwards and others, "How Effective is CAI? A Review of the Research," Educational Leadership, 33:147-9+, November, 1975.

[46] Judith Edwards and others, "Is CAI Effective?," Association For Educational Data Systems, 7:124, Summer, 1974.

[47] J. F. Vinsonhaler, and R. K. Bass, "Summary of Ten Major Studies on CAI Drill and Practice," Educational Technology, 12:30-32, July, 1972.

In reviewing related research, studies were found to be highly diverse with multiple objectives, making classification extremely difficult. The purpose of this chapter was to: 1) reveal investigations germane to this study, 2) show how collateral researchers handled avenues of approach to the solution of similar difficulties 3) disclose additional information sources, 4) help put this research in an historical perspective with previous research, and 5) assist in evaluating this research in comparison to the efforts of others. As stated by Phelps: "Without a careful examination of the literature, investigators will not know what has been researched and will thus find it difficult to know what remains to be done."[49]

Organization of the report. In general, this report can be divided into two broad sections. The first half, presented in chapters one and two, covers information leading up to the experiment. The second half covers information dealing directly with the experiment, encompassing experimental procedures, presentation of data, analysis of data, a summary, conclusions and recommendations.

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[48] Robert J. Seidel, "It's 1980: Do You Know Where Your Computer Is?," Phi Delta Kappan, 61:484, March, 1980.

[49] Roger P. Phelps, A Guide to Research in Music Education (Metuchen, N. J.: The Scarecrow Press, 1980), p. 77.

# CHAPTER III

## PROCEDURES AND METHODOLOGY

The basic stages of development in this study were: 1) design of the experiment, 2) collection of data, 3) description of data collected, and 4) conclusions with attendant recommendations. This chapter will cover experimental design and collection of data.

Setting of the experiment. Permission to initiate a research project in music instruction employing computer-assisted instruction at Eastern New Mexico University was granted by Dr. Jon Jonsson, Director of the School of Music. Eastern New Mexico University is located in Portales, New Mexico. ENMU is a state-supported university with an on-campus enrollment of about 4,000. The school of Music is fully accredited by the National Association of Schools of Music. The music faculty numbers seventeen, and there are about one hundred and forty full time music majors.

Population of the experiment. Freshmen music majors at Eastern New Mexico University enrolled in Music 151, Creative Musicianship. The Creative Musicianship course for school year 1980-81 was divided into two sections. One section of students had piano background, and the other section of students had no piano background. The population of this experiment contained the section of students without piano background.

The population included fourteen students. One section of the pre-test contained general questions about the population that may have effected the results of the study. The answers to the questions showed the following information. Ten of the fourteen students stated no previous experience with a computer, while all of the students had used one or more electronic games. Eleven of the students stated that working with mechanical objects was enjoyable. Since the musical tones used in this experiment are generated by a small synthesizer, students were asked if they enjoyed music played by a synthesizer. All but two of the students said that at least part of the music they have heard performed on a synthesizer was enjoyable. On the basis of a personal assessment, each student was asked to characterize their class load as light, medium, or heavy. None of the students said their schedule was light, ten said medium, and four said that their schedule was heavy. The students were also asked to remark on whether they had any activities or responsibilities that might interfere with their class work. The only remarks made to this question were that seven of the fourteen students were working part time at various jobs. A question concerning typing ability showed four poor, six fair, four good, and no excellent typists. This question was asked because the students were required to record their answers into the computer using a typewriter-like keyboard. One half of the students declared their major musical performance medium as vocal and the other half instrumental. The last question concerned musical background. All fourteen were involved in music instruction while attending public school. Six received private instruction while eight received no formal private instruction in music (Appendix A).

Selection of the samples. Before being divided into a control and an experimental group, the fourteen students in the population were given a three week adjustment period using the computer. During this time a pre-test divided into three sections was administered. At the conclusion of the pre-test, the totaled raw scores of the students were arranged in an array, with the highest score on top and the lowest score on the bottom of the list. Using the random number generator on the computer, seven students were randomly assigned to the experimental group and seven to the control group. This was done by starting at the top of the array of student pre-test scores. If the random number generated by the computer was odd, the student was assigned in the experimental group, and if the random number was even, the student was assigned to the control group. This procedure was followed until there were seven students in each of the groups.

The independent variable. Also known as the stimulus or antecedent variable, the independent variable is the computer-assisted instruction which was intended to cause a change in student achievement. Related to the independent variable, the following practices were followed throughout the fifteen week period of the experiment:

1. A class lecture was used to show the students how to use the computer. A three week period of adjustment was the next step in the experiment. All sudents were told to sign up for two thirty-minute time periods. During these two thirty-minute sessions, students were asked to become acquainted with the instructional process and advance as far as possible with each program.

2. During the duration of the experiment all students attended their regular music theory and ear-training class for fifty minutes, five days a week. Three days a week were spent primarily with music theory. The other two days a week were spent with sight-singing and other ear-training not covered in the computer programs.
3. The computer lab was used as an aid to the instructional process.
4. Supervision of the experimental and control groups was by the researcher; however, the supervision entailed only time-monitoring and assistance with mechanical operation. Instructional assistance was not part of the supervision.
5. Students were allowed to use the computer more than the two thirty-minute sessions originally set as a guideline.
6. The learning environment was the same for all students.
7. Evaluation and classroom procedures were the same for all students.

*The dependent variable*. Also known as the response or criterion variable, the dependent variable is observed to see the effects of student achievement as a result of the treatment placed upon the experimental group. The experimental group in this study was subject to the theories of the competency-based education movement; namely, a commitment to the behavioral specification of both educational objectives and the evaluative procedures for each learning activity. Design of objectives is mainly concerned with student achievement. Once the student has reached the objective with a high percentage of correct answers, he or she is considered to have developed a competence in that area. Performance objectives are statements of specific actions that a student will be able to perform after satisfactorily mastering a learning activity. Also contained in the performance objectives are the standards of evaluation.

Events that lead to increased use of competency-based performance objectives in education are: 1) employers wanted to know what can be stated, in specific terms, about the achievement of a student graduating with a music degree, 2) the university staff was interested in locating areas of weakness, and what had not been covered, and 3) parents wanted to know specifically what had been learned in their children's education. These three points are the major impetus for the competency-based education movement. Some of the questions in the competency-based movement that have not yet been answered are: 1) how, and by whom is it to be decided what is a level of "competence", 2) how can non-observable behavior be considered in objectives, and 3) a well designed exam can demonstrate knowledge but does this mean career success; does knowledge equal performance?

The questions of competence-based education leave room for a great deal of additional research. The study of the competency-based dependent variable in this experiment is one small investigation toward the improvement of learning in music education.

Hardware considerations. Before any experiment concerning computer-assisted instruction can be undertaken, the computer hardware must be obtained. The first step involved decisions concerning the type of computer hardware most appropriate for this experiment. Within the alloted budget, two main directions became evident. First, a terminal could be purchased that would tie into the main computer at the university. This would involve a great deal of time and development to include systems that would generate musical tones. The second alternative was to purchase a stand-alone microcomputer. This was the route selected for this experiment.

There are a small number of different microcomputers available on the market. Each of these computers are similar in basic features and design. Two of the specific computer design features important to this experiment are a refined graphics display to include the musical staff and a system for generating musical tones. The one microcomputer with excellent graphics and a small synthesizer to produce musical tones was the Apple II from Apple Computer Inc., Cupertino, California. One other reason the Apple II Microcomputer was chosen is the availability of software already developed to be used in music computer-assisted instruction. A list of the equipment employed in this experiment is as follows:

1. Apple II Microcomputer with 48K memory
2. Disk II drive with controller card
3. Monitor
4. MMI Music Board
5. Speaker
6. Paper Tiger printer

The Apple II Microcomputer comes with 16K to 48K memory. A 48K memory was needed in this experiment. A 48K memory means there are forty-eight thousand bits of memory available to the programmer. The disk drive is used to read information from the storage disk and transmit this information into the computer. The controller card for the disk contains a series of microelectronics used to drive the disk machine. This controller card is placed in slot seven inside the microcomputer, and connected with a series of cables. The monitor is very similar to a small black and white television set. The students see the display of instructional material on this monitor. The MMI Music Board was purchased from Micro Music Incorporated, Normal, Illinois. This music board is actually a small synthesizer capable of producing up to four tones simultaneously within a range of four octaves. The speaker employed had to be of sufficient quality to minimize distortion when sounding the musical tones to be studied by the students. A Paper Tiger printer was also purchased to be used in future development of computer software.

Once received, the equipment went through a procedure known as "power up." Power up is the connecting of cables and checking all computer functions.

The computer was found to operate as advertised. During the fifteen weeks of the experiment, there were no malfunctions in the computer or peripheral equipment.

Computer software. Three individual computer programs were used during the experiment. Each of the programs were stored on a separate disk. The process of reading the information from the disk into the computer is known as "booting." First, with thumb on the label, the disk was put into the disk drive. Next, the student closed the door on the drive, thus placing a head on the disk. The students then followed a typewriter sequence on the keyset. To get into BASIC computer language the operator must type: (RESET), then hold down the (CTRL) key while typing (B). When the " > " sign appeared on the monitor, (P) (R) (#) (7) and (RETURN) was entered into the computer. The computer then automatically booted the disk and proceeded to run the program. This booting procedure seemed complicated at first to the students; however, after one week there were no problems in getting started. A poster placed on the wall in front of the computer reviewing this step-by-step process helped students greatly.

The disks containing the computer software were the most fragile of all equipment used in the experiment. Students were given the following specific information dealing with the handling of disks. Each diskette is a five inch plastic disk specially coated so that information may be stored on or erased from its surface. The coating is similar to the magnetic coating found on tape used in tape recorders. The diskette is sealed in a square black plastic cover which protects it, helps keep it clean, and allows it to spin freely. The diskette is also called "floppy disk" because of its flexible qualities. Older computer information storage devices that worked on similar principles used rigid disks. While the diskette and its cover are somewhat flexible, actually bending the diskette can damage it. This was the first caution given to students. Secondly, the students were asked not to let anything touch the surface of the diskette. Each diskette can hold over 931,000 bits of information. A microscopic scratch or even a fingerprint can cause the disk to be permanetly damaged. The third warning was to keep diskettes away from magnetic fields. This means to keep them away from electronic motors, magnets, and electronic devices such as television sets. The diskettes are also sensitive to extreme temperatures. These cautions concerning diskettes were understood by every student involved in the experiment. Due to the care taken by the students there were no problems with damage to the disks.

The machine, used to read the software from the disk, was the Disk II drive. Unlike the Apple II, it is a mechanical device with motors and moving parts. Students were made aware of the care needed when using the disk drive. No mechanical failures in the disk drive were noted during the experiment.

Once the studnets were made aware of the special precautions involved in the experiment, the next step was familiarizing them with the three software packages to be used. The first program introduced to the students was entitled "Doremi," authored by Dr. Bruce Benward. Doremi teaches aural identification of the individual degrees of a major scale. The steps in the program are:

1. The student types his or her name into the computer. The name is later used when the total correct answers are tallied and reported.
2. The student must choose the level of difficulty ranging from one tone up to four tones.
3. The student must read the instructions presented on the display screen.
4. The number nine and the return key are typed to have the computer sound the scale. This may be done as many times as desired.
5. When the scale is familiar, only the return key is typed. This tells the computer to sound one or more of the tones to be

identified.

6. The student tells the computer his or her answer by typing either scale numbers (1,2,3,4, etc.) or syllables (do, re, mi, fa, etc.). Most of the students in this experiment used scale numbers because they were not as familiar with the syllables.
7. Once the answer was entered, the computer told the student whether it was correct or incorrect. If the answer was correct, it gave congratulations, a report card, and proceeded to the next exercise. If the answer was incorrect, it played the tone selected, then the correct tone, and gave a brief explanation on how it fits into the scale.

The students began at the easiest level, that of naming one tone of the scale at a time. Once a ninety percent level of accuracy had been gained, the students moved up to naming two tones at a time. The speed of advancement was determined by each student's ability. If a more difficult level was attempted and more than half the answers were missed, students moved back to an easier level until more confidence could be gained.

The second CAI program introduced to the students was "Interval Mania." Authored by Dr. David B. Williams and Dr. David L. Schrader, this program is designed to teach visual and/or aural identification of music intervals. One unique feature of this program is that the instructor can set the parameters for determining the order of difficulty. There are five control variables that can be set: 1) interval sizes, 2) interval classifications, 3) mode (aural or visual), 4) clef, and 5) difficulty level. For the three week introductory period of this experiment, none of the control variables were preset. Students chose their own intervals, mode, clef, and difficulty level. By allowing students to choose their own level, observations on performance could be made. It was generally observed that students often choose parameters far above their present ability. Due to this observation and the nature of the experiment, the parameters of the control variables were preset in the program. In an attempt not to be overly difficult for the less experienced students and not too easy for the advanced students, the following parameters were preset: interval sizes and classification were set on all major intervals, perfect intervals and the tritone. When students worked with this program they did not deal with any minor, augmented, or diminished intervals. The mode of presentation was set on aural. The computer initially sounded the interval without the notation being displayed. Once the interval size (unison to octave) and classification (perfect, or major) was correctly identified, the computer displayed the interval on a grand staff and sounded it once more. If the visual mode had been preset, the computer displayed and sounded the interval simultaneously.

The difficulty level is determined by the amount of time alloted for the answers. The timer was set on the easiest level. This timer is displayed on the screen as an hourglass simulating the trickling of sand. If the student beat the clock, an extra ten bonus points would be added to the total points.

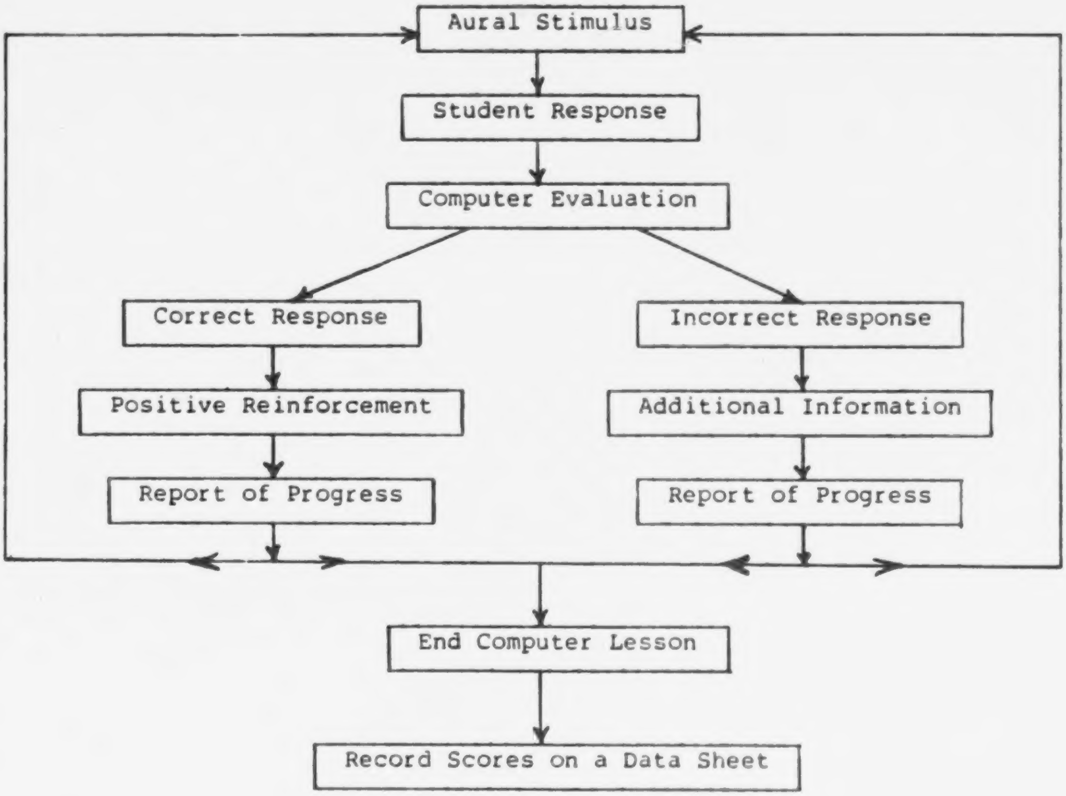
One other feature of Interval Mania is the option that two students can use the computer at the same time. This two-person type of learning can work well with students who are closely matched in ability and enjoy competition. Out of the fourteen students included in this experiment, four took advantage of working in competition. Interval Mania keeps a running scoreboard of student progress. The scoreboard shows rounds played, total points, bonus points, and grand total. To receive bonus points in each individual round the student must obtain eighty points before the clock runs out. The computer was preset to award sixteen points for each correct answer. The strategy is to identify as many intervals as possible within the fixed time frame.

The third program used in this experiment was also written by Dr. David B. Williams and Dr. David L. Schrader, entitled "Melodious Dictator." This software package teaches students to hear melodies and notate each note on a music staff, a process often called melodic dictation. The student follows a specific instructional sequence when using Melodious Dictator. First, the computer allows the student to begin at his or her desired level of difficulty, then a music grand staff and piano keyboard are displayed on the screen. The melody to be notated is then sounded twice by the computer. Using the left/right arrow keys on the Apple keyboard, the student locates the correct note on the piano keyboard by placing the arrow over the piano key and pressing the space bar. If a student did not know the names of the keys on the piano or the lines and spaces of the music staff, the letter names could be displayed. If the answer was incorrect, the student is given another chance to answer.

A unique feature of Melodious Dictator is the self-adjusting difficulty of the melodies to match the student's individual dictation ability. Two factors are used in adjusting the difficulty of the melodies: the length of the melody, two to seven tones in length, and the size of skips used in composing the melody, minor seconds to octaves. The most basic melody is a two-note unison. The most difficult melodies contain skips from a minor second up to an octave and are seven notes long. If a student kept his accuracy score above seventy percent, the melodies continued to become more difficult. If the student's score fell below seventy percent, the computer presented progressively easier melodies until the performance level reached seventy percent or higher. The melodies were generated in the computer program using a routine which randomly selected tones from a diatonic scale within either a major or a minor mode. Using this procedure allowed each run of the program to produce new and unique sets of melodies. This means the student could work with Melodious Dictator for many hours of practice and always have new melodies. Three different synthesizer timbres were randomly selected to vary the tone color of each melody. Once the Melodious Dictator session was completed the student received the following data for record keeping: 1) starting level of difficulty, 2) ending level of difficulty, 3) starting length of melody, 4) ending length of melody, 5) total notes notated, 6) total notes correct, and 7) overall competence.

After each student finished working with one of the three programs, he or she recorded the final scores on a data sheet (Appendix B). Data sheets were used to check weekly progress. The instructional process of the CAI lessons is diagrammed in Figure 1.

Figure 1. Basic steps in CAI programs.



*The instrument variable*. An objective criterion examination was used as a pre-test and a post-test measure encompassing the gamut of material studied during the treatment period. The criterion test for the study was developed specifically for this experiment. A total of 160 questions were asked. These questions were modeled after the exercises found in the computer programs (Appendix C,D).

*Test controls*. A piano was utilized in administering the test, thus providing a stimulus that remained constant. The piano was used in the testing because of its general use by musicians, and further, because of its general acceptance in ear-training courses. A written script of procedure and instructions was followed during the actual test. Identical test questions, instructions, and procedures were followed for the pre-test and post-test. Questions concerning student background and attitude were different on the pre-test and post-test.

*Limitations of the study*. The following were limitations placed upon and related to this study.

1. The population was limited to one section of Music 151, Creative Musicianship, at Eastern New Mexico University during the fall and spring semesters of the 1980-81 academic year.
2. Only those students enrolled for fall and spring semesters were included in the study.
3. The regular classroom material was taught by a faculty member in the School of Music.
4. Students signed a schedule on the door of the CAI room for a suggested time of two, thirty-minute sessions per week. Any additional use of

the computer was on a first-come-first-use basis.

5. The computer room, known as the CAI Lab, was open from eight a. m. to five p. m., five days a week.
6. Three software programs were available for student use.
7. One Apple II Microcomputer was used by the fourteen students.

Hypotheses to be tested. The first hypothesis tested for the study:

$H_0$: There is no significant difference between the achievement scores of the pre-test and post-test.

The second hypothesis tested for the study:

$H_0$: There is no significant difference between the achievement scores of the experimental and the control groups.

Both hypotheses were disigned to be tested at a ninety-five percent level of significance.

The experimental procedures. The experiment consisted of the contrast between two treatment conditions. The subjects in both of these conditions were treated identically, except for one feature that was different. All the subjects began the experiment with a three-week period of familiarity. During these three weeks students were told to advance as far as possible. After the three-week period, the population was randomly divided into an experimental group and a control group. The control group continued learning under the same conditions already in progress. Specific objectives were defined to the experimental group. The treatment or objectives given to the experimental group were as follows:

1. Achieve a minimum of eighteen correct out of twenty executions in the two-note level using the Doremi program.
2. Achieve a minimum of one hundred and sixty points after two rounds of the Interval Mania program.
3. Achieve a minimum of seventy percent accuracy when naming seven notes in level four of the Melodious Dictator program.

The method used for the study is called the Pre-test/Post-test Control-Group Design.

# CHAPTER IV

## ANALYSIS OF DATA

The data gathered for this study are analyzed in four segments. The first segment deals with the two hypotheses of the experiment. The second segment covers curricular implications of the Apple II Microcomputer as it pertains to Eastern New Mexico University's music program. The third segment presents the findings of student attitude toward ear-training as measured at the beginning and ending of the experiment. The final portion represents the results of a learning styles inventory administered to the students to determine whether this test can be helpful to the instructor in directing student use of computer-assisted instruction.

The primary problem. As stated in chapter one, this study is intended to determine which of two groups of college freshman music majors will demonstrate greater achievement in learning auditory discrimination. The researcher has chosen two hypotheses to answer the problem.

The first hypothesis states there is no significant difference between the achievement scores of the pre-test and post-test. This hypothesis is tested previous to the primary hypothesis, because if the population did not show significant improvement, it would be useless to compare the scores of the experimental and control groups. A t-test was used to test the hypothesis (Table 2 and 3).

Table 2. Control group scores.

| Raw Score Pre-Test | Raw Score Post-Test | Difference $X_2 - X_1$ |
|---|---|---|
| $X_1$ | $X_2$ | $d$ |
| 37 | 78 | 41 |
| 43 | 67 | 24 |
| 49 | 71 | 22 |
| 82 | 141 | 59 |
| 28 | 154 | 26 |
| 137 | 151 | 14 |
| 150 | 156 | 6 |

$\bar{X}_1 = 89.429$ $\bar{X}_2 = 116.857$ $\bar{d} = 27.43$ $\alpha = .05$ $s_d = 17.6$

$H_0: \mu_d = 0$ $(H_a: \mu_d \neq 0)$

Test Statistic: $\bar{d}$

Standardized Form: $\dfrac{\bar{d} - \mu_d}{s_d / \sqrt{n}} \sim t_{(n-1)} = t_{(6)}$

Calculated Value: $\pm t_{6,\ .025} = \pm 2.447$

Obtained Value: 4.124

Failure to Accept $H_0$

Table 3. Experimental group scores.

| Raw Score Pre-Test | Raw Score Post-Test | Difference $X_2 - X_1$ |
|---|---|---|
| $X_1$ | $X_2$ | $d$ |
| 47 | 100 | 53 |
| 73 | 96 | 23 |
| 86 | 127 | 41 |
| 104 | 132 | 28 |
| 104 | 118 | 14 |
| 112 | 148 | 36 |
| 131 | 155 | 24 |

$\overline{X}_1 = 93.857$ $\overline{X}_2 = 125.142$ $\overline{d} = 31.286$ $\alpha = .05$ $s_d = 13.03$

$H_0: \mu_d = 0$ $(H_a: \mu_d \neq 0)$

Test Statistic: $\overline{d}$

Standardized Form: $$\frac{\overline{d} - \mu_d}{s_d / \sqrt{n}} \sim t_{(n-1)} = t_{(6)}$$

Calculated Value: $\pm t_{6, .025} = \pm 2.447$

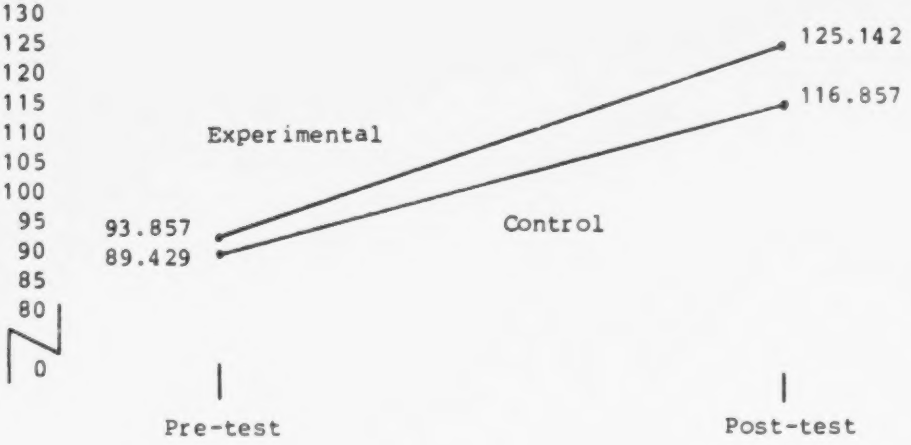
Obtained Value: 6.35

Failure to Accept $H_0$

Failure to accept the null hypotheses using a t-test states that students in the control and experimental groups did show a significant amount of achievement on test scores.

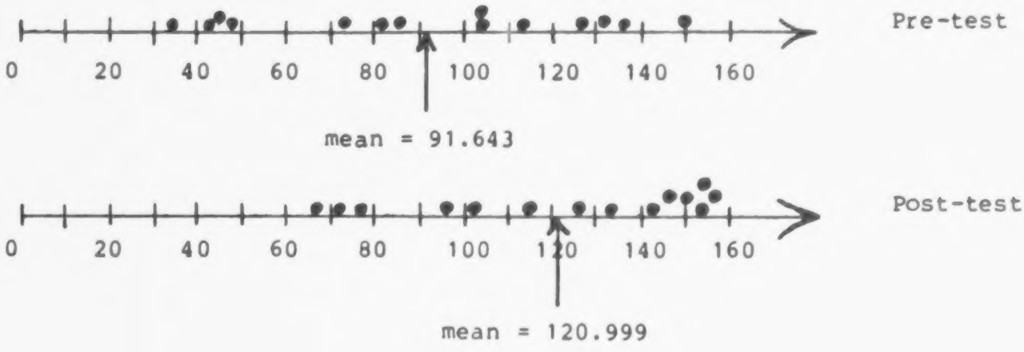
A chart shows the improvement scores of both groups (Figure 2).

Figure 2. Line graph of pre-test/post-test scores.



A dot array diagram shows improvement from pre-test to post-test. Interestingly, this diagram also shows the large spread in test scores. One of the difficult problems in teaching an ear-training class is the spread of ability. CAI can help deal with this problem through individualized instruction (Figure 3).

Figure 3. Dot array diagram of pre-test/post-test scores.



Now that significant improvement has been shown, the primary hypothesis can be tested. The primary hypothesis states there is no significant difference between achievement scores of the experimental and the control groups (Table 4).

Table 4. Test of primary hypothesis.

$H_0: \mu_1 - \mu_2 \le 0 \; (H_a: \mu_1 - \mu_2 > 0)$

Experimental Group: $n_1 = 7$ $\bar{X}_{d1} = 31.286$ $s_1 = 13.03$

Control Group: $n_2 = 7$ $\bar{X}_{d2} = 27.43$ $s_2 = 17.6$

Test Statistic: $\bar{X}_1 - \bar{X}_2$ $\alpha = .05$

Standardized Form: $$\frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{s^2p \;\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t_{(n_1 - 1 + n_2 - 1)} = t_{(12)}$$

$$s^2p = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)\, s_2^2}{(n_1 - 1) + (n_2 - 1)}$$

Calculated Value: $t_{12,\ .05} = 1.782$

Obtained Value: 4.654

Failure to Reject $H_0$

Failure to reject the null hypothesis using a t-test states that there is no significant difference between the achievement of the experimental and control groups. It can be seen that the experimental group achieved a mean difference score of about 3.8 points higher, but this number is not significant when the standard deviation and population sizes are considered.

In order that the total variance in the experiment be considered, a Two-Way Analysis of Variance with interaction was untartaken (Table 5 and 6).

Table 5. Randomized complete block with replications

Tests

| Groups | Pre-test | | | Post-test | | | |
|---|---|---|---|---|---|---|---|
| Control Group | $X_{111}$ | 37 | | $X_{121}$ | 78 | | $\overline{X}_{1..}$ = 103.143 |
| | $X_{112}$ | 43 | $\overline{X}_{11.}$ = 89.429 | $X_{122}$ | 67 | $\overline{X}_{12.}$ = 116.857 | |
| | $X_{113}$ | 49 | | $X_{123}$ | 71 | | |
| | $X_{114}$ | 82 | | $X_{124}$ | 141 | | |
| | $X_{115}$ | 128 | | $X_{125}$ | 154 | | |
| | $X_{116}$ | 137 | | $X_{126}$ | 151 | | |
| | $X_{117}$ | 150 | | $X_{127}$ | 156 | | |
| Exper. Group | $X_{211}$ | 47 | | $X_{221}$ | 100 | | $\overline{X}_{2..}$ = 109.499 |
| | $X_{212}$ | 73 | | $X_{222}$ | 96 | | |
| | $X_{213}$ | 86 | $\overline{X}_{21.}$ = 93.857 | $X_{223}$ | 127 | $\overline{X}_{22.}$ = 125.142 | |
| | $X_{214}$ | 104 | | $X_{224}$ | 132 | | |
| | $X_{215}$ | 104 | | $X_{225}$ | 118 | | |
| | $X_{216}$ | 112 | | $X_{226}$ | 148 | | |
| | $X_{217}$ | 131 | | $X_{227}$ | 155 | | |
| | $\overline{X}_{.1.}$ = 91.643 | | | $\overline{X}_{.2.}$ = 120.999 | | | $\overline{X}_{...}$ = 106.321 |

Table 6. Analysis of variance table.

| Source of Variation | Sums of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| due to Groups | 282.786 | 1 | 282.786 | 1 |
| due to Tests | 6,032.481 | 1 | 6,032.418 | 4.463 |
| due to Interaction | 26.012 | 1 | 26.012 | 1 |
| due to Exp. Error | 32,436.992 | 24 | 1,351.541 | |
| Total | 38,778.208 | 27 | | |

$H_0$: No differences between groups (fail to reject)

$H_0$: No interaction between groups and test (fail to reject)

$H_0$; No difference between tests

$\alpha = 5\%$

Test statistic = $\frac{\text{MS(TESTS)}}{\text{MS(ERROR)}} \sim F_{(1,24)}$

Critical value = $F_{.05,1,24} = 4.26$

Calculated value = 4.46

Failure to accept $H_0$

The null hypothesis in this analysis is rejected, thus supporting the results of the t-test. Stated another way, the treatment placed upon the experimental group had no significant effect upon their achievement.

The first subproblem. What are the cirricular implications of the microcomputer as it pertains to Eastern New Mexico University's music program? The answer to this question is philosophically based on the premise that the computer is not an instructional system in competition with the teacher. The role of the computer, like other resources in the classroom, is to amplify the skills and time of the instructor. The present economics of education will not change so as to reduce the student-teacher ratio. By using microcomputers, instruction can contain features of individualization. This researcher does not consider the microcomputer to be a panacea, but it is certainly more than an electronic game. Curricular implications will be discussed under eight main headings: advantages, testing, drill, tutorial, problem solving, data analysis, simulation, and courses.

One of the primary advantages of CAI is that the instruction can adjust to individuals. Some of the differences in student learning considered in a computer program are: 1) beginning level, 2) pace, 3) preferred type of reinforcement, 4) deficiency in basic skills and knowledge, 5) history of responses, and 6) presentation strategies. Music instruction through computer assistance can allow music students to receive individual attention designed for particular learning requirements and needs.

At defined stages of the instruction, the teacher could receive that in some areas of instruction, learning is enhanced by errors. For example, without errors minute differences in pitch may not be learned.

The computer also has the capability of storing large amounts of detailed records comprising each student's performance record. This data will be valuable to the instructor in evaluating the quality of instruction. If there are questions or topics that show a high percent of error, steps can be taken to correct the problem areas.

The computer also provides endless patience. Ear-training involves many repetitions before accuracy and consistency have been established. Learning situations in the classroom could take advantage of skills learned in the CAI lab to stimulate and develop creativity. Instruction utilizing computers can be developed to include aesthetic judgements as well as error analysis. Listed has been a review of the most important advantages found in learning situations utilizing computer-assisted instruction. As research and development of CAI continues, further advantages will emerge.

Computer-managed testing provides specific characteristics. The computer can store questions in desired categories relative to topic and difficulty. Thus, compiling an appropriate test becomes a matter of selecting questions from the computer memory. The computer can also randomize the questions making each test individual while asking the same questions. Tests can be executed at terminals or printed by the computer quickly and inexpensively. The tests that are completed at a computer terminal can be scored and recorded immediately. Schedules for completion of the exam can be as flexible or as stringent as desired by the instructor. Valuable statistics about the tests can be automatically figured, such as class average, item-difficulty index, and the point biserial correlation which are extremely tedious to figure by hand. These statistics can aid in instructional improvement. Instructors can develop consistency in testing for placement, entrance, and graduation competence. Upon entering the university, students could take computer-managed tests to diagnose recommended courses, locate deficiencies or cater to special interests.

Computerized testing, as a part of the instructional process, allows for a more frequent evaluation of achievement. This type of testing could also free the instructor to spend time with other important duties.

A curriculum employing CAI can be planned to provide the drill and practice of skills required in music learning. Courses involved with drill are sight-singing, ear-training, harmony, form, analysis, counterpoint, music literature, and arranging.

The tutorial aspects of CAI are the teaching of new skills or concepts and review of material. If a student finds one particular topic interesting enough for further study, there could be programs developed to provide an educational supplement. Tutorial CAI lessons could also be used to enhance class lectures and concepts presented in the test. After attending class, the review routine could give the student an evaluation of his or her knowledge. This allows the student self-testing, and concept development with opportunities for prompt remedial study.

Problem solving utilizing a computer will involve data manipulation found cumbersome by hand. For example, determining the transposed notes of a twelve-note scale. In problem solving it is possible to enter a tone row and have the inversion, retrograde, and retrograde-inversion printed quickly. Problem solving could also aid in the manipulation of mathmatical formulas or statistics involved in music composition.

Using data analysis, the computer could be used in studying the qualities of a musical score. An entire composition could be entered into the computer memory; then, software could analyze melodic, rhythmic, and harmonic patterns. Phrase length, construction, use of dynamics and other musical elements unique to each composition could be carefuly analyzed. This type of analysis does not take the place of human analysis, but it could be a tremednous asset in some types of analysis. In performance teaching, data analysis can be used to detect microscopic errors in intonation.

Computer simulations are models of experience and are open for a great deal of research and development. With the use of audio playback equipment and video disks, simulation seems to have endless possibilities. One area of computer simulation already developed involves music composed and/or performed through a computer medium. One example might be requesting the computer to sound a composition in a minor mode rather than the original major mode. The computer could be instructed to change the harmony from open chords to closed position chords. The possibilities seem to be limited by one's imagination.

A curriculum employing CAI can also include specific courses dealing with computers and music. One basic course could be named "An Introduction to Computer Applications in Music." The course design would include a fundamental understanding of the principles of computer technology in music education. Also included could be an overview of CAI, experience in using pre-programmed courseware, beginning programming, and definitions of terminology.

Another basic course could involve the teaching of computer literacy. This separate course in music computer programming is important because of the special features of music programs. Languages to be learned are BASIC, PASCAL, APPLESOFT, and others deemed appropriate. Once a knowledge of computer languages is learned, there can be instruction in the designing of learning experiences. Included should be a review of material previously developed. Development should be directed toward the evaluation and improvement of instructional courseware.

One other course could involve the administrative use of microcomputers. This could cover the use of pre-programmed software or development of new software. Different types of inventory programs, updating of student records, and maintenance of mailing lists are some of the computer uses in administration.

The addition of new courses may be impractical for music education curricula such as at Eastern New Mexico University. Computer literacy can be developed through other learning avenues in the university setting. Professional conferences, in-service workshops, summer workshops, visiting consultants, and demonstrations through other courses are important directions toward teaching educational applications of the computer in a music curriculum.

In conclusion, the major focus of a curriculum designed with computer assistance is achieving the desired goals to the highest possible level in the shortest amount of time. The curriculum should be carefully designed with specific and general desired outcomes. Allowances should be made for students who can guide their own learning with the computer, students that need a great deal of guidance, and possibilities between these two poles. The effectiveness of learning depends upon the student, teacher, and the method of computer applications.

_The second subproblem_. Through observation of student use and pre/post-test questions, can student attitude toward ear-training be shown to improve or deteriorate? The first part of this question deals with the researcher's subjective observation of student attitude toward CAI. In general, student attitude was observed to be positive and enthusiastic when first introduced to the computer. After the novelty of this technology diminished, students seemed to settle down to a routine of learning with CAI. These observations are not based on scientific evidence, but are the researcher's subjective judgements.

Questions on the pre-test and post-test concerning student feelings were also a part of the attitudinal portion of this study. The pre-test contained one question dealing with attitude: is your first impression of computer-assisted instruction positive or negative? All fourteen students replied with a positive answer. The post-test contained several questions on attitude in an attempt to analyze in more detail student feelings after fifteen weeks of CAI. The questions were answered as follows:

| | | AGREE | DISAGREE |
|---|---|---|---|
| 1. | I enjoyed CAI because it lets you take part in each step of learning. | 14 | 0 |
| 2. | CAI is nothing but a baby-sitter for the teacher. | 0 | 14 |
| 3. | I enjoy using CAI. | 14 | 0 |
| 4. | Generally, CAI did not give clear explanations of material. | 0 | 14 |
| 5. | I felt comfortable using CAI. | 14 | 0 |
| 6. | I would encourage my friends to try CAI. | 13 | 1 |
| 7. | CAI makes me feel as though I am not a person. | 0 | 14 |
| 8. | CAI made good use of examples and illustrations. | 12 | 2 |
| 9. | CAI makes me angry when I get the wrong answer. | 6 | 8 |
| 10. | I should have spent more time using CAI this semester. | 10 | 4 |
| 11. | Computers ought to become more important in the everyday life of today. | 10 | 4 |

12. Now that you have used CAI for one semester, is your attitude toward it positive or negative?

Positive - 13 Negative - 1

"It helps the students to learn the material at their own rate, which doesn't put competitive pressure upon the individual."

"I enjoyed it and it has helped my ear-training alot."

"It has helped tremendously with my intervals and if I would use it more, I'm sure my dictation skills would improve much more."

"I can say CAI helped me more than if I went to the keyboard. I would like to continue using CAI if possible."

"It helps your ear."

"My attitude is positive. I am glad I don't have to work with it anymore, but it did help me. I have a good ear, but I needed to be able to do more with it. I feel that the CAI has helped me develop my ear."

"I find it boring. I think the first two programs were too easy. It is hard for me to go in and use it because I feel like I'm wasting time."

"Very positive - the combination of sight and sound with physical action, plus the kind of coordination use, was an extremely effective and enjoyable teaching and learning tool."

"The computer is a good thing to have students learn by. It's real helpful in many ways."

"Its much easier and much more fun to have the computer play tones and try to identify them than to play them on the piano yourself."

"It is positive because before I started using CAI I had a lot of trouble with ear-training, now I have only a little trouble. It has helped me a great deal."

"Because of CAI, I am positive. It has helped me most with my ear."

13. Please list the things you liked about CAI.

"The illustrations when you get the wrong answer."

"A solid reinforcement method to study ear-training."

"I liked the time limit on Interval Mania."

"Clear directions, easy to work with, convenient."

"I can't go into detail about what I liked. I just enjoyed using CAI."

"It helped my ear a little bit."

"It helped me to see where I needed help and with what."

"The step-by-step confidence-building and the positive reinforcement - the way it celebrated when I was right."

"Just about everything. When I used it I really enjoyed it. I should have used it more."

"You could progress at your own level and your own pace."

"It was different - some kind of a change. I liked that method of learning."

"It kept my interest."

14. What was your favorite program?

Melodious Dictator - 7
Interval Mania - 6
Doremi - 0

"I liked them all."

"The Melodious Dictator was my favorite because I was able to learn more from it."

15. Please list the things you disliked about CAI.

"I didn't feel the grading system on the computer was fair. I also didn't like the time schedule."

"A permanent station (like in the library) that could be used at night would make the times more managable."

"The same silly little routines after each thing gets irritating after a while."

"There was nothing I disliked about CAI."

"I disliked the tritones, because I always thought it was something else."

"I didn't like the repeated scolding when I was repeatedly wrong."

"It got me very upset at certain points."

"It seemed to make it harder to hear intervals on the piano. The T. V. screen tended to make my eyes hurt after about 15-20 minutes!"

"It really was too easy."

"None."

In summary, the students attitude toward CAI was generally positive. One student out of the fourteen said her attitude was negative because Doremi and Interval Mania were too easy. The positive and negative comments lead to possible improvements in the management of a CAI lab. A broad analysis of these attitudinal questions indicates that the CAI lab was successful, although there are many questions that remain to be answered.

The third subproblem. Will the results of the learning styles inventory be helpful to the instructor in directing student use of computer-assisted instruction? This subproblem asks for a comparison between student achievement scores and the results of a learning styles inventory. The inventory was administered to students during the second week of the experiment. Like individual appearance among people, the possible variations in student learning styles are infinite. Learning style describes a student in terms of those educational conditions under which he or she is most likely to learn. Preferred ways of learning emerge from inborn, natural inclinations as well as life experiences. Although a detailed analysis of learning styles would be impractical in this study, it seems important to take advantage of the available data.

The learning styles inventory used in this study was developed by Dr. Albert A. Canfield. This inventory was developed to measure some of the affective variables that seem to effect learning, and which contribute to adjustment of the teaching-learning situation. The four major categories measured are conditions, content, mode, and expectation. Students took the inventory during one fifty minute class period (Appendix E). Results were tallied on the Learning Styles Inventory Percentile Profile (Appendix F). The first eight scores on the inventory profile reflect the conditions or motivational forces of learning situations. They cover four major areas: affiliation, structure, achievement, and eminence. Affiliation is friendly, warm, and supportive relations with the instructor or peers. Structure is logical, orderly, well-defined, and clear study plans in the organization or detail of the course work. Achievement is independence of action, pursuit of self-interests, and self-set objectives in relation to self-perceived capabilities and interests. Eminence is comparing oneself to others through competition and/or the desire for classroom discipline.

The next four questions on the profile sheet reflect content. The four major areas included are: 1) numeric, working with numbers and logic, 2) qualitative, working with words or language, 3) inanimate, working with objects, and 4) people, working with interviewing and counseling.

The third group of questions on the profile sheet reflect mode. Mode is the general form through which learning is preferred. The four modes of learning considered on the profile sheet are: 1) listening, 2) reading, 3) ionic or seeing, and 4) direct experience. The final portion of the inventory profile reflects expectation, which is the level of performance anticipated.

A group analysis of the learning inventory profile compared with student achievement scores shows some general conclusions. Among the four students acieving the most improvement, ranging from forty-one to sixty points, the following characteristics are shown:

1. The condition with the highest rating in this group is the competition category, desiring comparison with others and needing to know how

one is doing in relation to others. Rated almost as high is the instructor category. Students wanted to know the instructor personally and desired a mutual understanding. Students also showed a liking for one another.

2. Working with people, interviewing, counselling, selling, and helping was the major area of interest.
3. The favored mode of learning was listening. Subsequently, a general dislike for the visual and direct experience mode was shown.
4. The student's anticipated expectancy level ranged from superior to below average or unsatisfactory.

Among the seven students achieving twenty-one to forty points improvement, the following characteristics are shown:

1. The condition rated slightly higher by the second group is the peer category, working in student teams, good relations with other students and having student friends. The indications of conditions were exceptionally diverse in this group. Desiring classroom discipline was rated fairly high, while a desire to know the instructor and specific information on assignments was rated fairly low.
2. Working with people, interviewing, counselling, selling and helping was indicated slightly higher as the major area of interest.
3. Viewing illustrations, movies, slides, pictures, and graphs were indicated as the preferred mode of learning.
4. The second group's anticipated expectency level was too diverse to demonstrate any real indications.

Among the three students achieving from zero to twenty points improvement, the following characteristics are shown:

1. The condition with the highest rating in the third group was knowing the instructor personally, having a mutual understanding and liking one another. The competition category was rated generally low.
2. Working with people, interviewing, counselling, selling, and helping was again rated as the major area of interest.
3. The preferred mode of learning in this group was the same as the group that advanced the most - - the category of listening, hearing information, lectures, tapes, and speeches.
4. The student's anticipated expectency level was again too diverse to demonstrate indications.

The learning characteristics generalized in the previous section were determined through the group summary interpretation directions included with the test. For the purposes of this study, the learning styles profile did show some general characteristics about student groups. This inventory does not present definitive evidence on every student, but could be helpful to the instructor in directing some student use of computer-assisted instruction.

# CHAPTER V

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The intent of this chapter is to provide a brief description of the study, to summarize the findings, to offer conclusions and recommendations based on the findings, and to submit suggestions for further research.

Summary. The purpose of this study was to determine which of two groups of fourteen college freshman music majors will demonstrate greater achievement in learning auditory discrimination. The method employed to accomplish this was a pre/post-test experimental design. Following a three week adjustment period using computer-assisted instruction, subjects were randomly assigned to a control or an experimental group. Following the determination of groups and the testing, a treatment consisting of specifically defined objectives was administered to the experimental group. The control group continued with the same procedure followed during the initial three-week adjustment period. The control group's objectives were not specifically defined. They were simply to improve as quickly as possible. Following the application of the treatment, twelve weeks in length, the same test used for pretesting was administered to all members in the experiment.

A statistical analysis of the data was used to examine the hypotheses. The first hypothesis:

$H_0$: There is no significant difference between the achievement scores of the pre-test and post-test.

This hypothesis was tested previous to the primary hypothesis; because in an experiment of this nature, a significant improvement in the population should be evinced before a comparison of groups is meaningful. The primary hypothesis:

$H_0$: There is no significant difference between the achievement scores of the experimental and the control groups.

Results of the analysis showed that there was significant gain in music achievement between the pre-test and the post-test. The primary hypothesis showed no significant difference between the achievement of the experimental group as compared to the control group. The specifically defined objectives assigned to the experimental groups caused no significant change in student achievement.

A descriptive inquiry into the curricula implications of the microcomputer as it pertains to Eastern New Mexico University's music program was also undertaken. Philosophically, the computer was considered to be a resource intended to amplify the skills and time of the instructor. The possibilities of individualizing parts of the instruction were seen to be the primary advantage of computer applications in music education. Curricular implications were discussed, which pertained to advantages, testing, drill, tutorial, problem solving, data analysis, simulation, and courses.

Attitudinal questions and observations were also a part of the study. The general attitude toward computer-assisted instruction was very positive. Student comments on the post-test showed constructive judgments for the improvement of managing a CAI lab and development of instructional courseware.

A learning styles inventory was administered to students during the second week of the experiment. Results from the inventory showed that with some students information gained would be useful to the instructor in directing use of CAI. This study has been an attempt to add to the body of knowledge pertaining to the educational applications of the computer.

Conclusions. A review of related literature, an analysis of student achievement, and observations of student attitude in this study has led to many more questions than answers. The following conclusions, reached as a result of this study, are based on the findings herein and are subject to the limitations of the study:

1. Computer-assisted instruction is valuable as a supplement to student learning of auditory discrimination at Eastern New Mexico University.
2. The specifically defined objectives developed for the experimental group had no significant effect when compared to the nonspecific objectives of the control group. However, different types of objectives and different ways of administering the objectives need to be considered in further studies.
3. When students are allowed to choose their own control variables in the lessons, the choices were usually too difficult for present ability.
4. Four of the fourteen students showed interest in using computer-assisted instruction in direct competition with one of their peers.

5. The variance in student ability and achievement was very diverse.
6. Curricular implications of computer-assisted instruction at Eastern New Mexico University are significant.
7. The initial attitude of students, in regard to using the computer for improving auditory discrimination, revealed a willingness to experiment with alternative methods of instruction.
8. Student attitude after using computer-assisted instruction for fifteen weeks was positive and showed a desire to continue using this mode of instruction.
9. Results of a learning styles inventory showed a great diversity among the fourteen students in this study. Characteristics of most students showing the greatest achievement were a desire for competition and a desire for a mutual understanding with the instructor.

Recommendations for further research. As related in this report, the field of computer-assisted instruction is far from being thoroughly explored. Additional research and development is needed. Reliance on a few individual pieces of research should be avoided. Replication is an important part of scientific inquiry. With consideration of this notion, and in keeping with the conclusions found in this study, several recommendations are suggested:

1. A similar study be undertaken that would test different ways of administering objectives.
2. A similar study be undertaken that would test different types of objectives.
3. Future study be conducted to identify other potentials of computer

lessons based on the theories of Gordon.[1]

4. A learning styles inventory be developed and tested specifically for use with computer applications.
5. Future study be undertaken that would test if student achievement on computer lessons is reflected by student achievement on classroom tests using a piano.
6. Further research could test other uses of computer-assisted instruction as an integral part of Eastern New Mexico University's music curricula.
7. A study which would address the need for computer-assisted instruction to develop aesthetic potential in music could be undertaken.

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[1] Edwin E. Gordon, Learning Sequences and Patterns in Music. (Chicago: G. I. A. Publications, 1980).

# APPENDICES

## APPENDIX A

### Demographic Material Related to the Student Population

| | Yes | No |
|---|---|---|
| 1. Previously worked with a computer. | 4 | 10 |
| 2. Previously used electronic games. | 14 | 0 |
| 3. Likes synthesizer music. | 11 | 3 |
| 4. Likes working with mechanical objects. | 12 | 2 |
| 5. Has received public school music instruction. | 14 | 0 |
| 6. Has received formal private instruction in music. | 6 | 8 |
| 7. Have a part time job. | 7 | 7 |

8. Class Load.

Light 0 Medium 10 Heavy 4

9. Typing ability.

Excellent 0 Good 4 Fair 6 Poor 4

10. Major performance medium.

Instrumental 7 Vocal 7

# APPENDIX B

Student Data Sheets For:

1) Doremi
2) Interval Mania
3) Melodious Dictator

# DOREMI DATA SHEET

NAME

| Date | Worked On: 1,2,3,or 4 notes | Total Correct | Total Worked |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
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| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# INTERVAL MANIA DATA SHEET

Name ____________________ Soc. Sec. No. ______________

| DATE | ROUNDS PLAYED | TOTAL POINTS | BONUS POINTS | GRAND TOTAL |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
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| | | | | |

# MELODIOUS DICTATOR DATA SHEET

Name ______________________________

Please respond to these items each time you complete a session with this program. The data will appear on the screen just as shown here when you are finished with the program.

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

DATE ______________________
STARTING DIFFICULTY LEVEL ______
ENDING DIFFICULTY LEVEL ______
STARTING MELODY LENGTH ______
ENDING MELODY LENGTH ______
TOTAL NOTES NOTATED ______
TOTAL CORRECT SCORE ______
OVERALL COMPETENCY ______

# APPENDIX C

## Pre-test

# PRE-TEST FOR CAI LAB

Name____________________

Date____________________

## Part I

1._____ 2._____ 3._____ 4._____ 5._____

6._____ 7._____ 8._____ 9._____ 10._____

11._____ 12._____ 13._____ 14._____ 15._____

16._____ 17._____ 18._____ 19._____ 20._____

## Part II

1._____ 2._____ 3._____ 4._____ 5._____

6._____ 7._____ 8._____ 9._____ 10._____

11._____ 12._____ 13._____ 14._____ 15._____

16._____ 17._____ 18._____ 19._____ 20._____

## Part III

1._____ 2._____ 3._____ 4._____ 5._____

6._____ 7._____ 8._____ 9._____ 10._____

11._____ 12._____ 13._____ 14._____ 15._____

16._____ 17._____ 18._____ 19._____ 20._____

## Part IV

1._____ 2._____ 3._____ 4._____ 5._____

6._____ 7._____ 8._____ 9._____ 10._____

11._____ 12._____ 13._____ 14._____ 15._____

16._____ 17._____ 18._____ 19._____ 20._____

Pre-test for CAI Lab p. 2

Part V

1. Have you ever worked with a computer before? (If "yes" give a brief explanation.)

2. What other types of electronic games or equipment have you used before:

3. Is your first impression of computer assisted instruction positive or negative?

4. Do you like music played on a synthesizer?

5. Do you like working with mechanical objects?

6. What is your class load this semester?

   light_____ medium_____ heavy_____

7. Do you work or have any other activity that may interfere with class work? (Give a brief explanation.)

8. List the three voice ranges or instruments you prefer to listen to. (In order of preference.)

9. Would you consider your typing ability to be excellent_____ good_____ fair_____ or poor_____?

10. On the back of this paper give a brief explanation of your musical background. (instruments played, voice range, performing ensembles, solos, ensembles, years of private study, previous theory classes, parents or brothers and sisters in music, etc.)

# PRE-TEST NO. 2 FOR CAI LAB

Name ____________________

Date ____________________

Part I

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____ 8. _____ 9. _____ 10. _____

11. _____ 12. _____ 13. _____ 14. _____ 15. _____

16. _____ 17. _____ 18. _____ 19. _____ 20. _____

Part II

1. ______ 2. ______ 3. ______ 4. ______ 5. ______

6. ______ 7. ______ 8. ______ 9. ______ 10. ______

11. ______ 12. ______ 13. ______ 14. ______ 15. ______

16. ______ 17. ______ 18. ______ 19. ______ 20. ______

Part III

1. _______ 2. _______ 3. _______ 4. _______ 5. _______

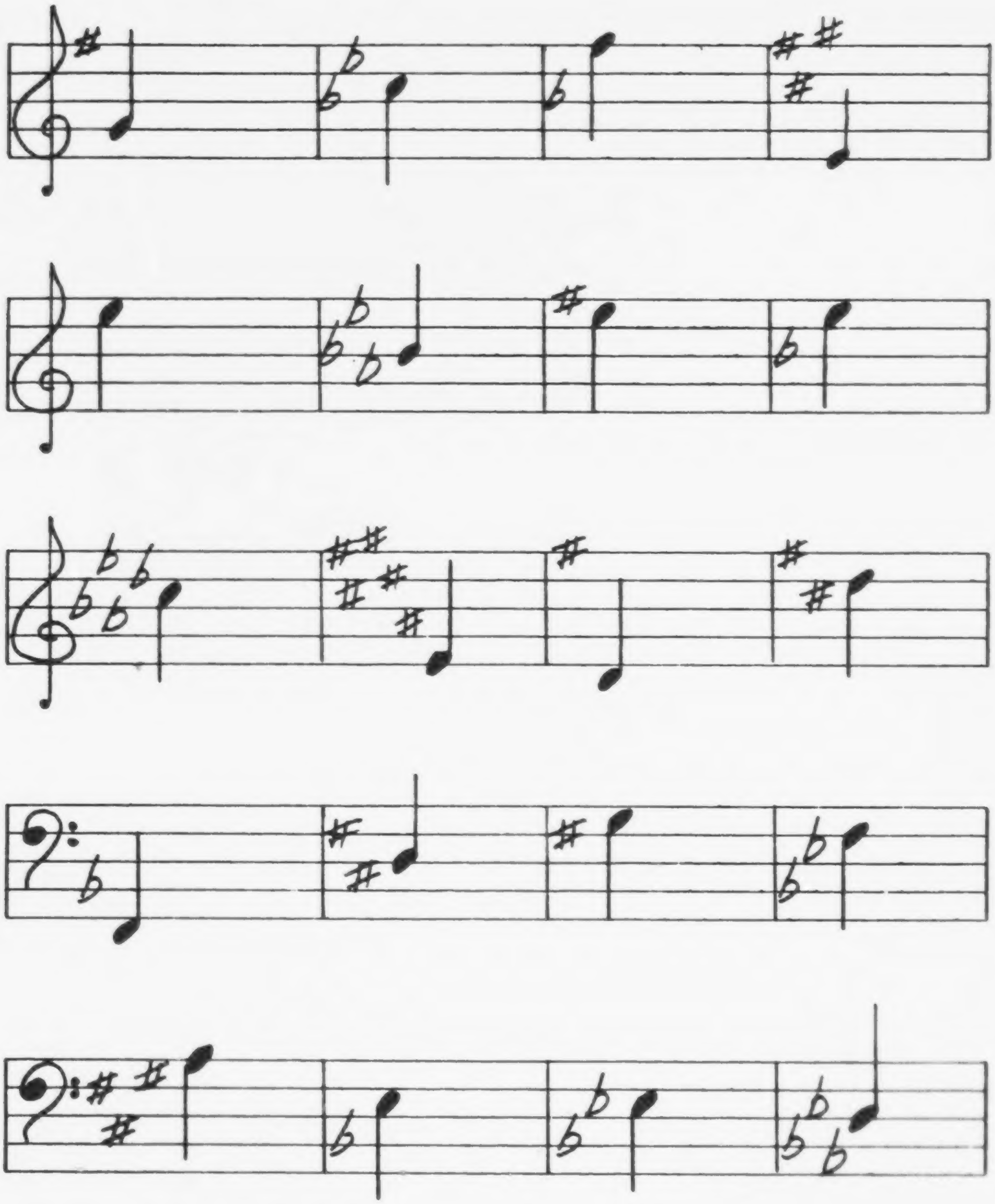
6. _______ 7. _______ 8. _______ 9. _______ 10. _______

11. _______ 12. _______ 13. _______ 14. _______ 15. _______

16. _______ 17. _______ 18. _______ 19. _______ 20. _______

# PRE-TEST NO. 3 FOR CAI LAB

Name____________________



# APPENDIX D

## Post-test

## POST-TEST FOR CAI LAB

Name______________

Date______________

Part I

1.____ 2.____ 3.____ 4.____ 5.____

6.____ 7.____ 8.____ 9.____ 10.____

11.____ 12.____ 13.____ 14.____ 15.____

16.____ 17.____ 18.____ 19.____ 20.____

Part II

1.____ 2.____ 3.____ 4.____ 5.____

6.____ 7.____ 8.____ 9.____ 10.____

11.____ 12.____ 13.____ 14.____ 15.____

16.____ 17.____ 18.____ 19.____ 20.____

Part III

1.____ 2.____ 3.____ 4.____ 5.____

6.____ 7.____ 8.____ 9.____ 10.____

11.____ 12.____ 13.____ 14.____ 15.____

16.____ 17.____ 18.____ 19.____ 20.____

Part IV

1.____ 2.____ 3.____ 4.____ 5.____

6.____ 7.____ 8.____ 9.____ 10.____

11.____ 12.____ 13.____ 14.____ 15.____

16.____ 17.____ 18.____ 19.____ 20.____

## POST-TEST FOR CAI LAB

Part V

1. Now that you have used CAI for one semester is your attitude toward it positive or negative? (please explain your answer in detail)

Part VI

| | AGREE | DISAGREE |
|---|---|---|
| 1. I enjoyed CAI because it lets you take part in each step of learning. . . . . . . | ____ | ____ |
| 2. CAI is nothing but a baby-sitter for the teacher. . . . . . . . . . . . . . . . | ____ | ____ |
| 3. I enjoy using CAI. . . . . . . . . . . . . . | ____ | ____ |
| 4. Generally, CAI did not give clear explanations of material. . . . . . . . | ____ | ____ |
| 5. I felt comfortable using CAI. . . . . . | ____ | ____ |
| 6. I would encourage my friends to try CAI. . | ____ | ____ |
| 7. CAI makes me feel as though I am not a person. . . . . . . . . . . . . . . . . . . | ____ | ____ |
| 8. CAI made good use of examples and illustrations. . . . . . . . . . . . . . . . | ____ | ____ |
| 9. CAI makes me angry when I get the wrong answer. . . . . . . . . . . . . . . . . . | ____ | ____ |
| 10. I should have spent more time using CAI this semester. . . . . . . . . . . . . . | ____ | ____ |
| 11. Computers ought to become more important in the everyday life of today. . . . . . | ____ | ____ |

page 3

# POST-TEST FOR CAI LAB

12. Please list the things you liked about CAI.

13. What was your favorite program? (Doremi, Melodious Dictator, or Interval Mania.)

14. Please list the things you disliked about CAI.

# POST-TEST NO. 2 FOR CAI LAB

Name______________

Date______________

## Part I

1._____ 2._____ 3._____ 4._____ 5._____

6._____ 7._____ 8._____ 9._____ 10.____

11.____ 12.____ 13.____ 14.____ 15.____

16.____ 17.____ 18.____ 19.____ 20.____

## Part II

1.______ 2.______ 3.______ 4.______ 5.______

6.______ 7.______ 8.______ 9.______ 10._____

11._____ 12._____ 13._____ 14._____ 15._____

16._____ 17._____ 18._____ 19._____ 20._____

## Part III

1._______ 2._______ 3._______ 4._______ 5._______

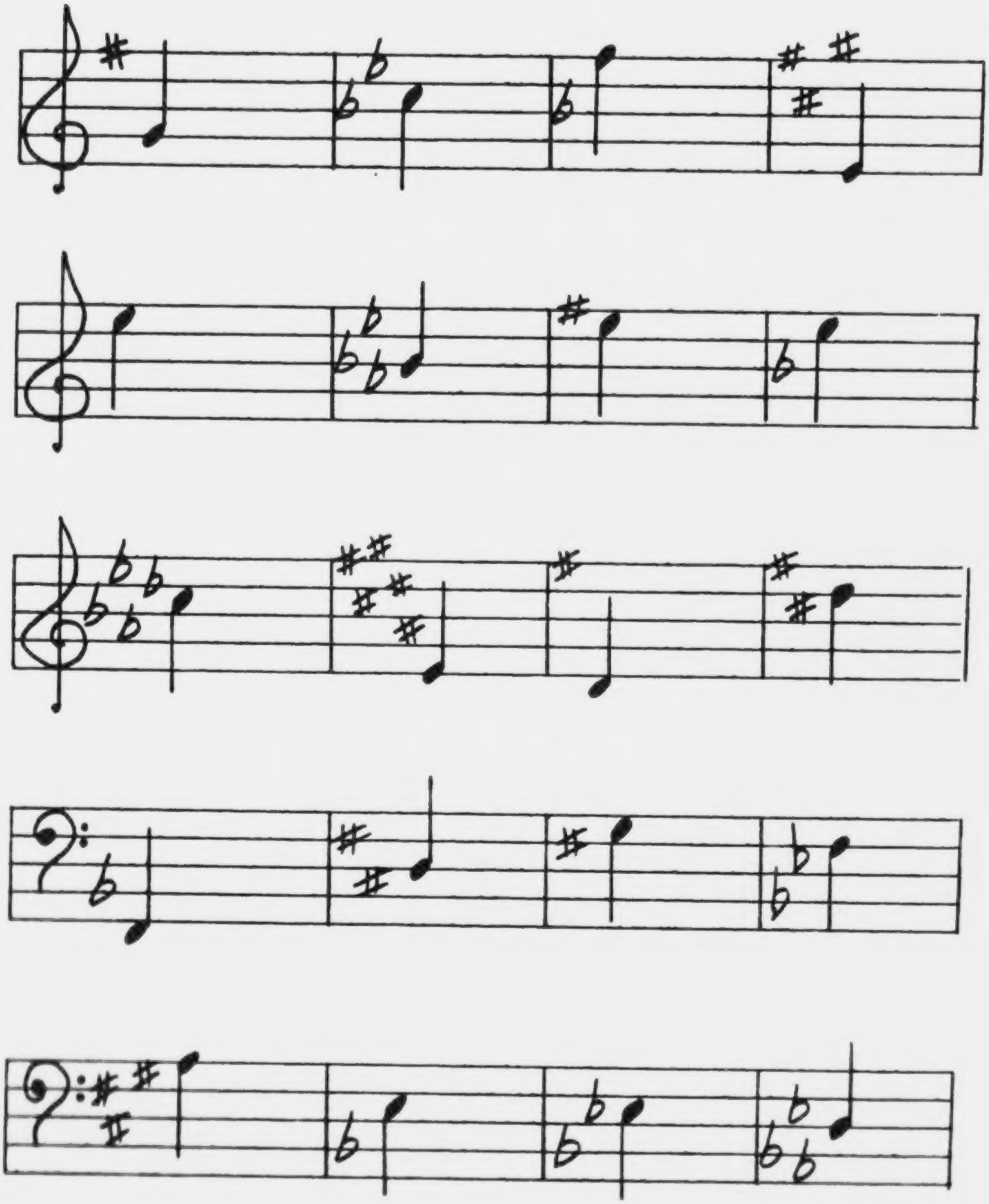
6._______ 7._______ 8._______ 9._______ 10.______

11.______ 12.______ 13.______ 14.______ 15.______

16.______ 17.______ 18.______ 19.______ 20.______

POST-TEST NO. 3 FOR CAI LAB

Name__________________



# APPENDIX E

## Learning Styles Inventory

# learning styles inventory

## Form S-A

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Developed by:
ALBERT A. CANFIELD, Ph.D.

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Northville, Mich. 48167

# Instructions

This inventory gives you an opportunity to describe how you learn best. There are no right or wrong answers. You are to read each of the 25 items, and rank the responses according to how well they describe your reactions or feelings. The example below illustrates how the items are presented. Examine it carefully to be sure you understand how you are to mark your answers.

## EXAMPLE:

**32** **Rank the following colors in the order in which you generally prefer them.**

a. Yellow
b. Red
c. Blue
d. Green

***Answer Sheet Example:***

a. 4 (least preferred)
b. 3 (third)
c. 1 (most preferred)
d. 2 (second)

You must write a number in each blank on your answer sheet to indicate how well each response expresses how you feel. All four responses must be ranked (from 1 to 4) for each item.

Note that the items are numbered from the top to the bottom on the pages of this booklet and on your answer sheet.

If you are sure that you know what you are to do, begin. If you have a question, ask for assistance before starting.

**ank the following items in terms of how well ιey describe the classes you've liked most. (1 ›r the mdst descriptive statement, 2 for the second most, etc.)**

I enjoyed the other students and we shared our ideas and feelings with each other.
The course was well organized and the topics followed one another in a meaningful sequence.
I more or less set my own goals and studied the things of most interest to me.
I knew how my work compared with others and the best work was fairly recognized.

**lumber the following descriptions of teachers ·om 1 to 4 in the order in which you normally refer them. (1 for most preferred, etc.)**

Teachers who are pleasant, friendly, and who take a personal interest in me.
Teachers who provide specific and clear information about assignments and requirements.
Teachers who give me the opportunity to decide what I want to study and how I want to do things.
Teachers who impose high standards and make me do the work necessary to accomplish them.

**ank the following courses in terms of their eneral appeal to you:**

Mathematics and physical science
Language and literature
Household and craft repair skills
Interviewing and counseling

**4. Rank the following in terms of their general value to you as ways to learn.**

a. Listening to others talk about a subject.
b. Reading what others have written about it.
c. Seeing pictures, graphs, movies, etc.
d. Handling or working with something tangible.

**5. Rank the following grades to indicate how likely you are to receive them on a paper or a report.**

a. Excellent or outstanding.
b. Good or above average.
c. Satisfactory or about average.
d. Unsatisfactory.

**6. Rank the following in the order in which they would be most helpful for improving your school experience in general.**

a. There were more group activities and opportunities to get to know other students well.
b. There were more class outlines and clearer statements about what the classes were all about.
c. There were more opportunities to think through my capabilities and set goals for my own performance.
d. There was more objective and frequent information on how my performance compares with others

**Rank the following in terms of how accurately they describe the worst teachers you've known.**

- They were more interested in the subject matter than in the students.
- They were vague about assignments and I was never sure what was expected of me.
- They were too restrictive in letting me do things on my own, coming to my own conclusions, etc.
- They were too easy and the students lost respect for them.

**Rank the following in the order in which you enjoy doing them.**

- Figuring out how things differ in cost.
- Writing a report or a letter.
- Building or repairing something.
- Carrying on a conversation with a stranger.

**Classes typically involve the following kinds of teaching activities. Rank them in the order in which you generally prefer them as ways to learn.**

- Lectures, audio tapes, and question-answer sessions.
- Textbook assignments and other readings.
- Movies, slides, graphs, charts, etc.
- Experiments or projects in the laboratory.

**Imagine that you have just received your grade on the final examination in a course that you felt was pretty easy and that you got the lowest grade in the class. Rank the following as to how you'd most likely feel.**

a. Somebody made a mistake in grading the papers.
b. I'd be quite surprised, because that doesn't happen very often.
c. It would surprise me a little, but that sometimes happens.
d. It wouldn't surprise me very much at all.

**In most courses, student performance is evaluated on some basis. Rank the following in terms of how you feel about such evaluations.**

a. They sometimes create jealousies and hard feelings among the students.
b. Sometimes they are unrelated to the supposed content and purposes of the course.
c. They sometimes aren't very helpful in evaluating my progress or in helping me focus my study activities.
d. Sometimes they don't really distinguish between those who are doing well and those not doing so well.

**Rank the following in terms of their value to you in learning.**

a. Having a chance to visit informally and develop an effective relationship with the teacher.
b. Having specifics on what courses include and what they require.
c. Having the chance to adopt my own approach and to make some contribution of my own.
d. Having scholarly teachers explain the material and direct my study in the most meaningful and useful direction.

**13. If you were in a course that required everyone to visit a home for the elderly, and you could do any of the following, rank them in the order of their interest to you.**

a. Help them compute their income taxes or balance their checkbooks.
b. Write a letter or read to them.
c. Help repair or replace something for them.
d. Sit and visit with them about their feelings.

**14. How do the following appeal to you as ways to find out about new occupations or types of work?**

a. Have someone in the field tell me about it.
b. Read a recent study explaining it.
c. Watch a classroom demonstration of the work.
d. Trying to do the work itself.

**15. Imagine that you have just turned in a paper to an instructor. Place a one by the letter of the response that describes how you think it would be most likely evaluated, a two by the second most likely, etc.**

a. Excellent
b. Above average
c. Average
d. Below average

**16. As a student, I feel it is my responsibility to:**

a. Cooperate with the other students and help them when I can.
b. Ask the teacher questions when the course is confusing or when the purpose isn't clear.
c. Make my own decisions as to what I can accomplish.
d. Assess the ability of the other students and work accordingly.

**17. Consider the following topics for teacher training and rank them in the order in which you think they would generally be most helpful to teachers.**

a. How to get along with students and maintain good relationships with them.
b. How to inform students of requirements, rules, the basis for grades, etc.
c. How to utilize independent study techniques so students can work more or less on their own.
d. How to maintain classroom discipline and get students to do the assigned work.

**18. Rank the following classes in the order in which they appeal to you.**

a. Formal logic and mathematics.
b. Developing the plot and writing short stories.
c. Operating a machine to make something.
d. Human behavior and the "helping" occupations.

**Rank the following in the order in which you would typically like to learn about the properties of a new plastic.**

a. Hearing a lecture.
b. Reading a book or text.
c. Viewing a movie or slides.
d. Experimenting with a small sample.

**Assume you are going to be in school next year, and rank the following evaluations in the order in which you think you'd receive them.**

a. In the top 10% or so.
b. In the top 25 or 33 percent.
c. In the middle 50 percent.
d. In the bottom 25 or 33 percent.

**Rank the following in terms of how accurately they describe the classes you have DISLIKED.**

a. There was a lot of arguing, bickering, or fighting among the students.
b. The class was disorganized and I couldn't tell what topic was coming next.
c. There was no opportunity for me to pursue my own special interests or branch off on anything.
d. No matter how well or how much anyone did, the teacher just accepted it.

**Rank the following in the order in which you feel they describe your most effective teachers.**

a. They like students and have a sincere desire to understand and help them.
b. They leave no confusion about what is to be done and how it is to be done.
c. They consider each person as an individual and let each student work to his abilities and interests.
d. They control their classrooms and require everyone to meet some minimum requirements.

**Club members are generally required to help in some way, rank the following in order of your preference for doing them**

a. Keeping the books on income, expenses, and finances.
b. Keeping the minutes of the meetings and doing the correspondence.
c. Setting up the room and keeping club equipment in order.
d. Greeting newcomers and helping everyone feel welcome.

**Suppose you were taking a course in Ecology. Rank the following in terms of how you'd like to study the topic.**

a. Hear speeches by qualified people.
b. Read reports and studies.
c. Watch movies, TV, films, etc.
d. Take field trips.

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25. **Rank the following in terms of how well they describe your feelings about your school performance.**

a. I've been at or near the top of my class.
b. I've been better than average.
c. I've been near the middle.
d. I've been in the lower half.

26. **Rank the following in their importance to you in the way classes are handled.**

a. There is an opportunity to develop friends and the students support one another.
b. The class sessions are logically related to each other and the topics follow an understandable and meaningful sequence.
c. Based upon the topic and my abilities, I can determine what areas I'll pursue.
d. Student's grades and the evaluation of their performance give fair recognition and credit to those doing the best.

27. **Rank the following in terms of how likely they would be as a reason for you to dislike a class.**

a. The teacher was hostile, easily angered, or inconsiderate.
b. There were vague standards and vague or frequently changing requirements.
c. There was too little opportunity to determine my own activities.
d. The teacher lacked the ability to direct and control the class.

28. **Rank the following in terms of their interest to you as a general field of work.**

a. Mathematics, engineering, accounting.
b. Language, writing, speaking.
c. Building, installing, operating equipment.
d. Interviewing, selling, teaching.

29. **Rank the following class activities in the order in which they normally appeal to you.**

a. The teacher lectures and answers questions.
b. I can read about the topic in a text or some outside reading.
c. Pictures, movies, graphs, displays, etc., are used.
d. I can experiment with or actually use the material.

30. **Imagine that you've just received the results of a final examination in a very difficult course and your grade was the highest in the class. Rank the following in terms of how you would most likely feel.**

a. I'd have expected to do well so it wouldn't surprise me.
b. I'd be surprised, but it could happen.
c. I'd feel like I had lucked out and guessed a lot of the correct answers.
d. I'd probably think that someone had made a mistake in grading the test.

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Northville, Mich 48167

# learning styles inventory

NAME ____________ (Last) ____________ (First) ____________ (Mid Initial)

INSTITUTION/SCHOOL ____________ DATE: ____________

CLASS/GROUP ____________ (Class, Program, etc.) AGE ____________ SEX ____________ (Male or Female)

**DIRECTIONS:** Be sure you enter a different number in each blank to indicate the order in which you ranked the responses to each item. (1 by the letter of the most descriptive response, 2 by the second most descriptive, etc., through 4.) The item numbers go down the page, as in the booklet.

1. a.____ b.____ c.____ d.____
2. a.____ b.____ c.____ d.____
3. a.____ b.____ c.____ d.____
4. a.____ b.____ c.____ d.____
5. a.____ b.____ c.____ d.____
6. a.____ b.____ c.____ d.____
7. a.____ b.____ c.____ d.____
8. a.____ b.____ c.____ d.____
9. a.____ b.____ c.____ d.____
10. a.____ b.____ c.____ d.____
11. a.____ b.____ c.____ d.____
12. a.____ b.____ c.____ d.____
13. a.____ b.____ c.____ d.____
14. a.____ b.____ c.____ d.____
15. a.____ b.____ c.____ d.____
16. a.____ b.____ c.____ d.____
17. a.____ b.____ c.____ d.____
18. a.____ b.____ c.____ d.____
19. a.____ b.____ c.____ d.____
20. a.____ b.____ c.____ d.____
21. a.____ b.____ c.____ d.____
22. a.____ b.____ c.____ d.____
23. a.____ b.____ c.____ d.____
24. a.____ b.____ c.____ d.____
25. a.____ b.____ c.____ d.____
26. a.____ b.____ c.____ d.____
27. a.____ b.____ c.____ d.____
28. a.____ b.____ c.____ d.____
29. a.____ b.____ c.____ d.____
30. a.____ b.____ c.____ d.____

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Birmingham, Michigan 48011

# APPENDIX F

## Learning Styles Inventory

## Percent Profile

# Learning Styles Inventory Percentile Profile

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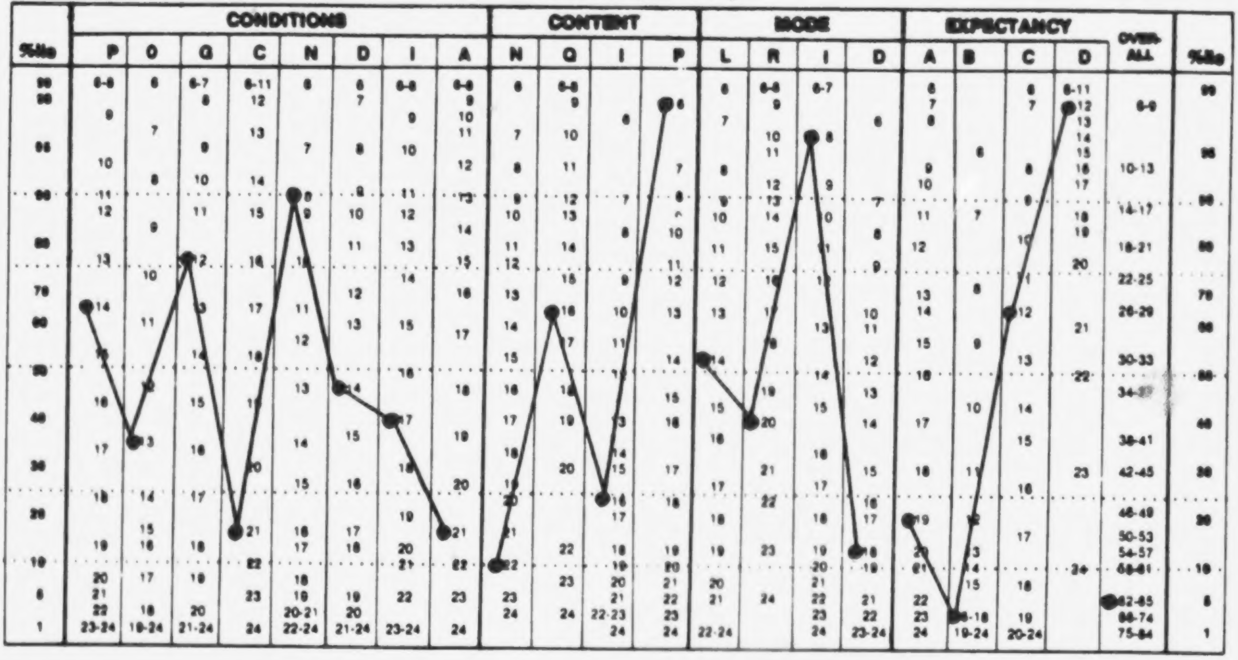
NAME Number One Achievement Score 41
(Last) (First) (Mid Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Control Group AGE ______ SEX MALE
(Class, Program, etc.) (Male or Female)

MALE ADULT (N = 1,384)



**Peer**: Working in student teams; good relations with other students; having student friends; etc.

**Organization**: Course work logically and clearly organized; meaningful assignments and sequence of activities.

**Goal Setting**: Setting one's own objectives; using feedback to modify goals and procedures; making one's own decisions on objectives.

**Competition**: Desiring comparison with others; needing to know how one is doing in relation to others.

**Instructor**: Knowing the instructor personally; having a mutual understanding; liking one another.

**Detail**: Specific information on assignments, requirements, rules, etc.

**Independence**: Working alone and independently; determining one's own study plan; doing things for oneself.

**Authority**: Desiring classroom discipline and maintenance of order; having informed and knowledgeable instructors.

**Numeric**: Working with numbers and logic; computing; solving mathematical problems; etc.

**Qualitative**: Working with words or language; writing, editing, talking.

**Inanimate**: Working with things; building, repairing, designing, operating.

**People**: Working with people; interviewing, councelling, selling, helping.

**Listening**: Hearing information; lectures, tapes, speeches, etc.

**Reading**: Examining the written word; reading texts, pamphlets, etc.

**Iconic**: Viewing illustrations, movies, slides, pictures, graphs, etc.

**Direct Experience**: Handling or performing; shop, laboratory, field trips, practice exercises, etc.

**Expectancy Score**: The student's predicted level of performance.

A. An outstanding or superior level
B. An average or good level
C. An average or satisfactory level
D. A below average or unsatisfactory level

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# Learning Styles Inventory Percentile Profile

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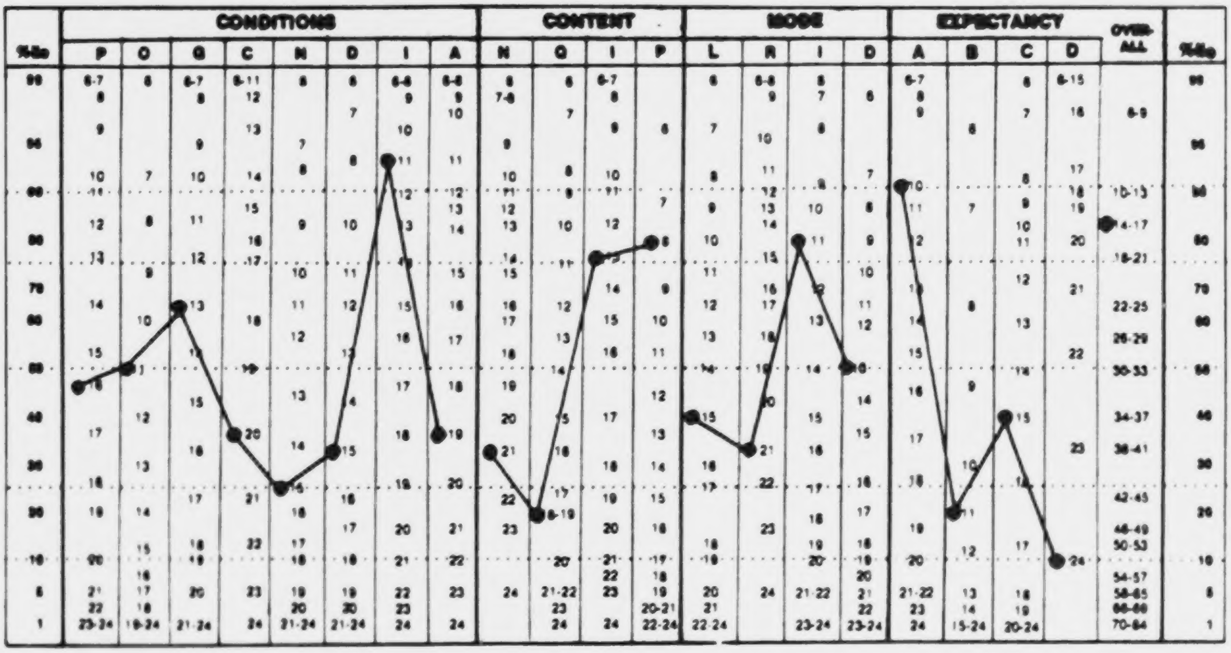
NAME Number Two (Last) Achievement Score 24 (First) (Middle Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Control Group (Class Program etc.) AGE ______ SEX FEMALE (Male or Female)

FEMALE ADULT (N = 1,180)



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**Expectancy Score**: The student's predicted level of performance.

A. An outstanding or superior level
B. An average or good level
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D. A below average or unsatisfactory level

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# Learning Styles Inventory Percentile Profile

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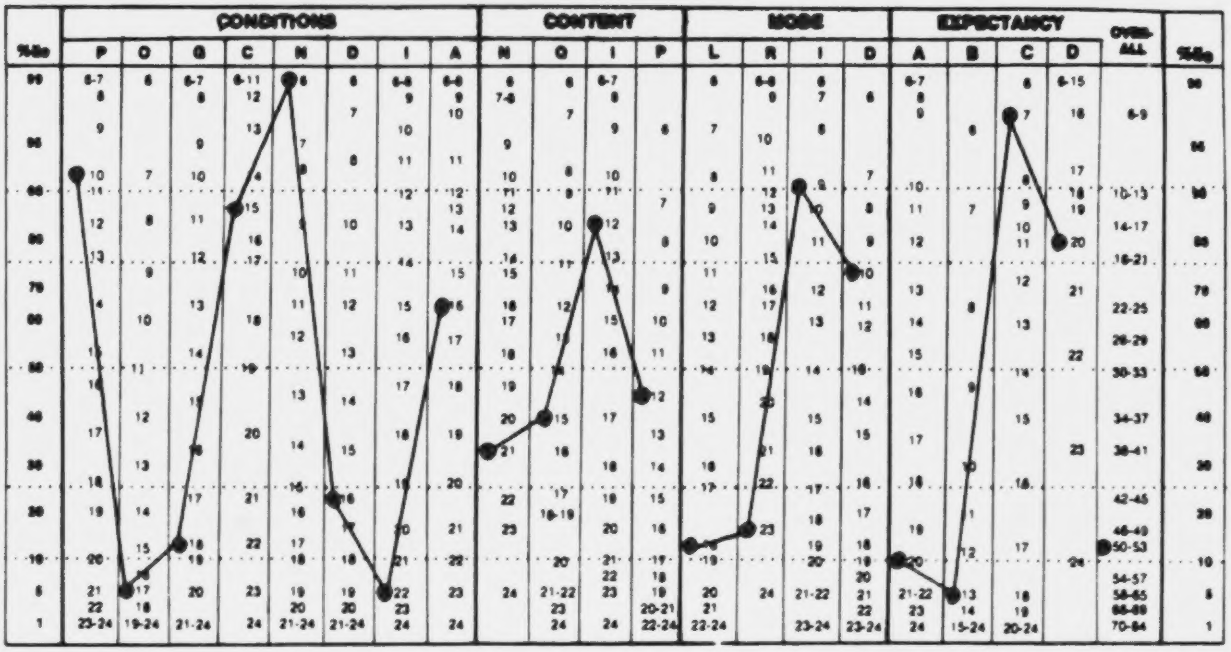
NAME Number Three (Last) Achievement Score 22 (First) (Mid. Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Control Group (Class, Program, etc.) AGE ______ SEX FEMALE (Male or Female)

FEMALE ADULT (N = 1,180)



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A. An outstanding or superior level
B. An average or good level
C. An average or satisfactory level
D. A below average or unsatisfactory level

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# Learning Styles Inventory Percentile Profile

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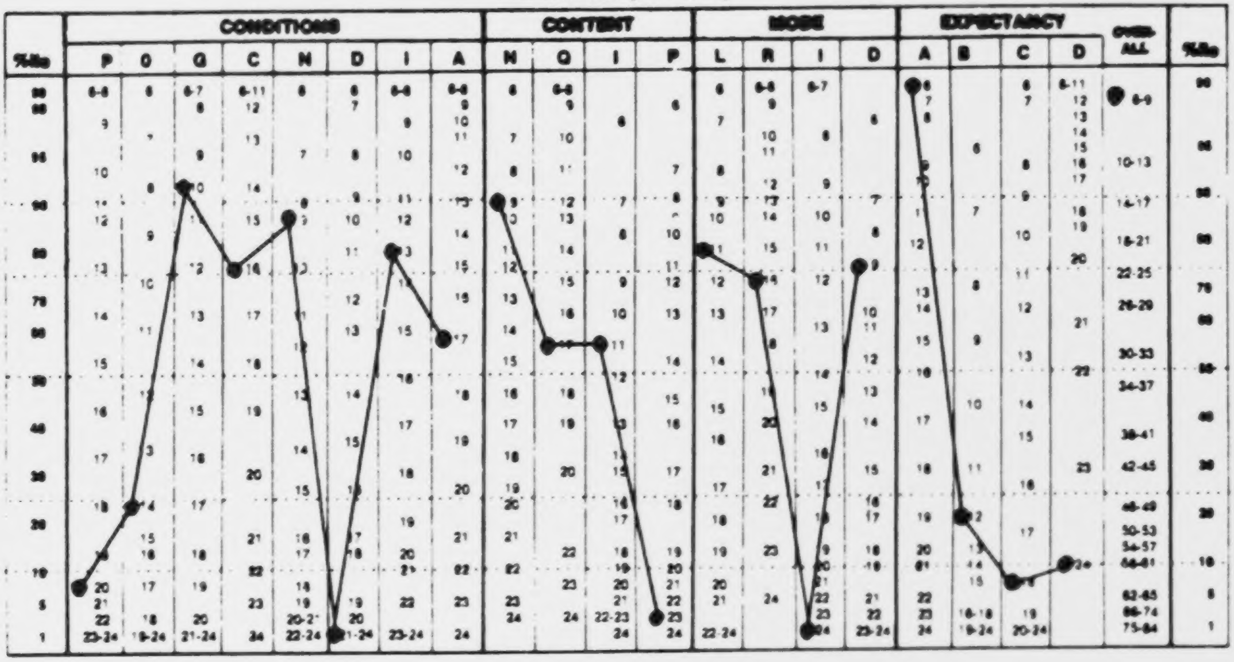
NAME Number Four Achievement Score 59

INSTITUTION SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS GROUP Control Group AGE ______ SEX MALE (Male or Female)

MALE ADULT (N = 1,364)



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**Expectancy Score**: The student's predicted level of performance.

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B. An average or good level
C. An average or satisfactory level
D. A below average or unsatisfactory level

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# Learning Styles Inventory Percentile Profile

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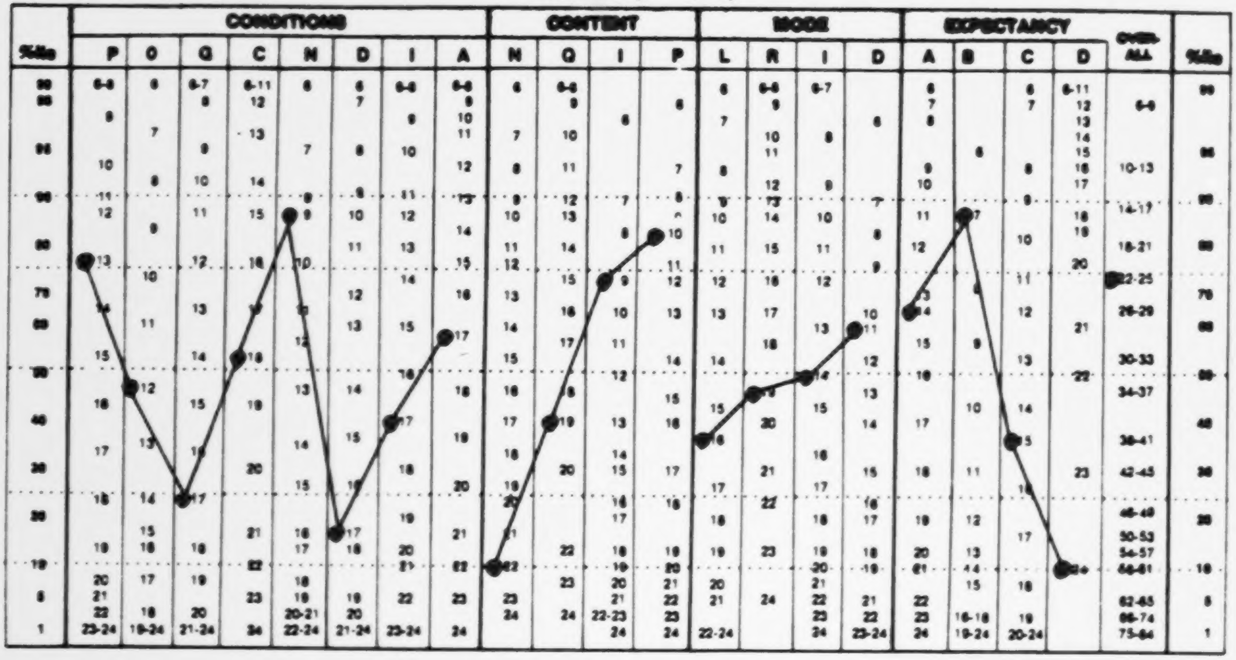
NAME Number Five Achievement Score 26

INSTITUTION SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Control Group AGE ______ SEX MALE

MALE ADULT (N = 1,384)



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**Direct Experience**: Handling or performing; shop, laboratory, field trips, practice exercises, etc.

**Expectancy Score**: The student's predicted level of performance.

A. An outstanding or superior level
B. An average or good level
C. An average or satisfactory level
D. A below average or unsatisfactory level

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# Learning Styles Inventory Percentile Profile

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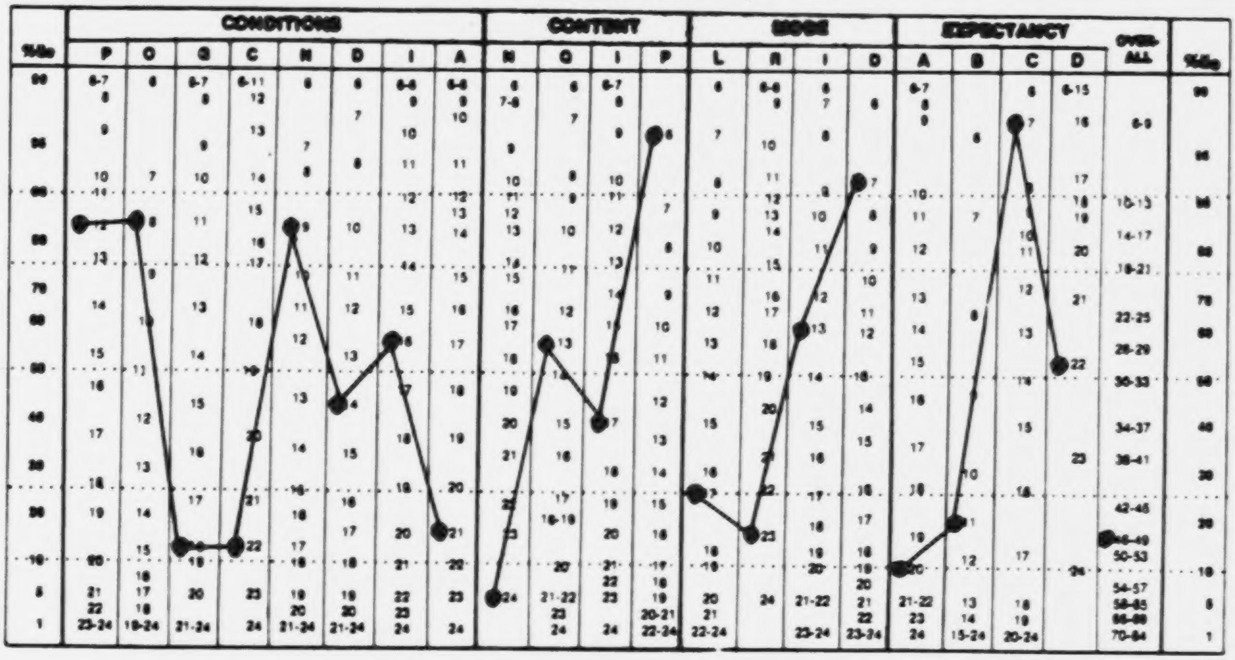
NAME Number Six (Last) Achievement Score 14 (First) (Mid initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Control Group (Class Program etc.) AGE ______ SEX FEMALE (Male or Female)

FEMALE ADULT (N = 1,180)



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# Learning Styles Inventory Percentile Profile

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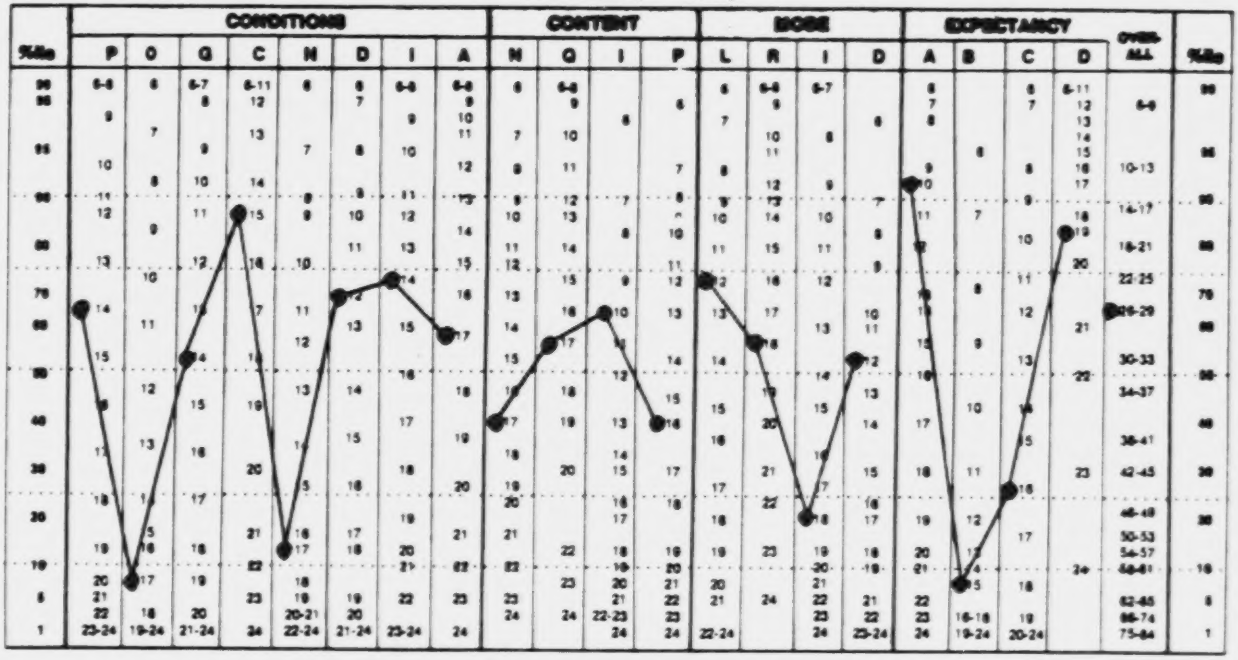
NAME Number Seven Achievement Score 6

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Control Group AGE SEX MALE

MALE ADULT (N = 1,384)



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# Learning Styles Inventory Percentile Profile

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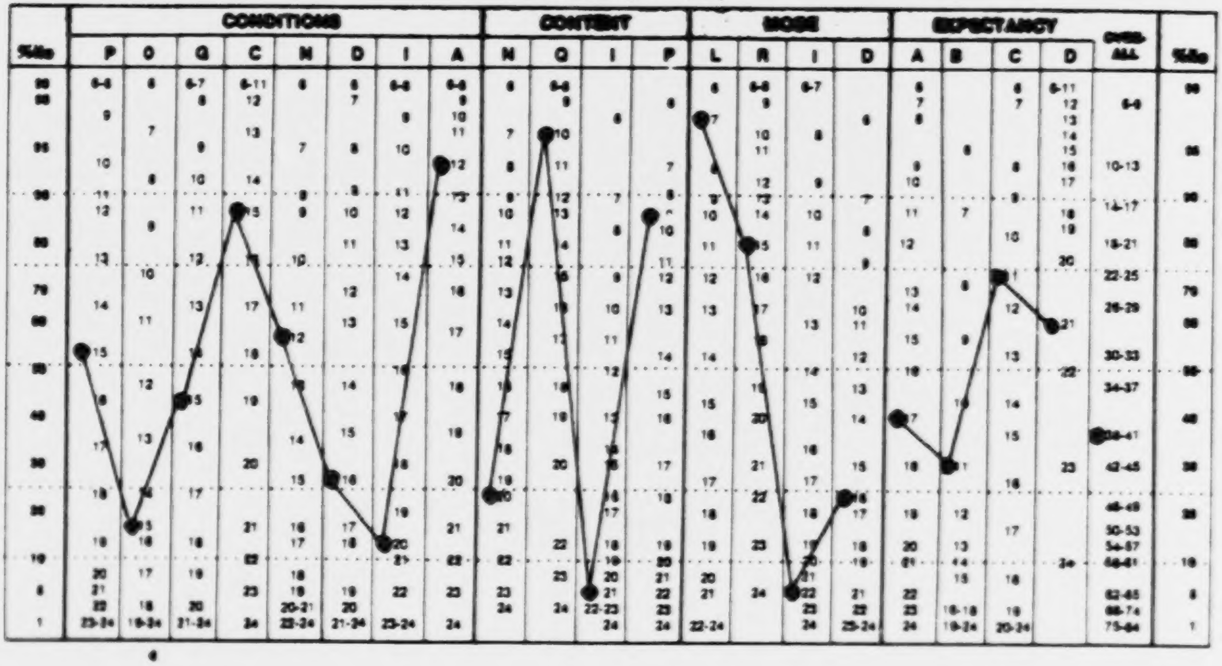
NAME Number One Achievement Score 53

INSTITUTION SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Experimental Group AGE ______ SEX MALE

MALE ADULT (N = 1,364)



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# Learning Styles Inventory Percentile Profile

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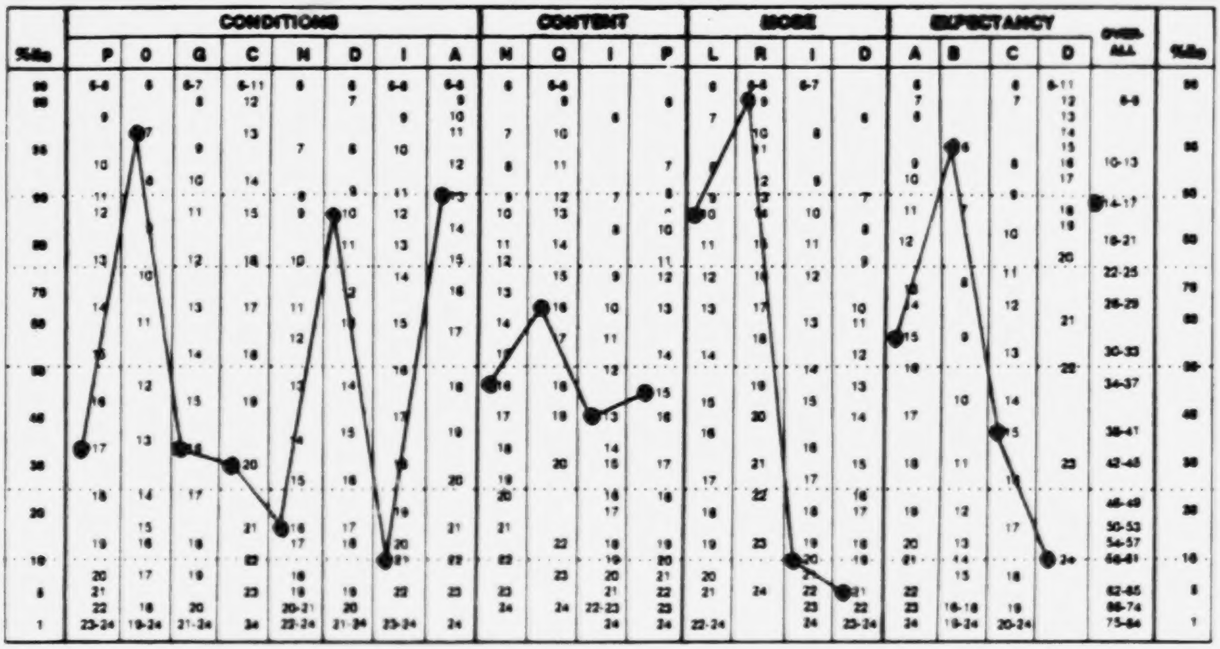
NAME Number Two (Last) Achievement Score 23 (First) (Mid. Initial)
INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981
CLASS/GROUP Experimental Group (Class, Program, etc.) AGE ______ SEX MALE (Male or Female)

MALE ADULT (N = 1,364)



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# Learning Styles Inventory Percentile Profile

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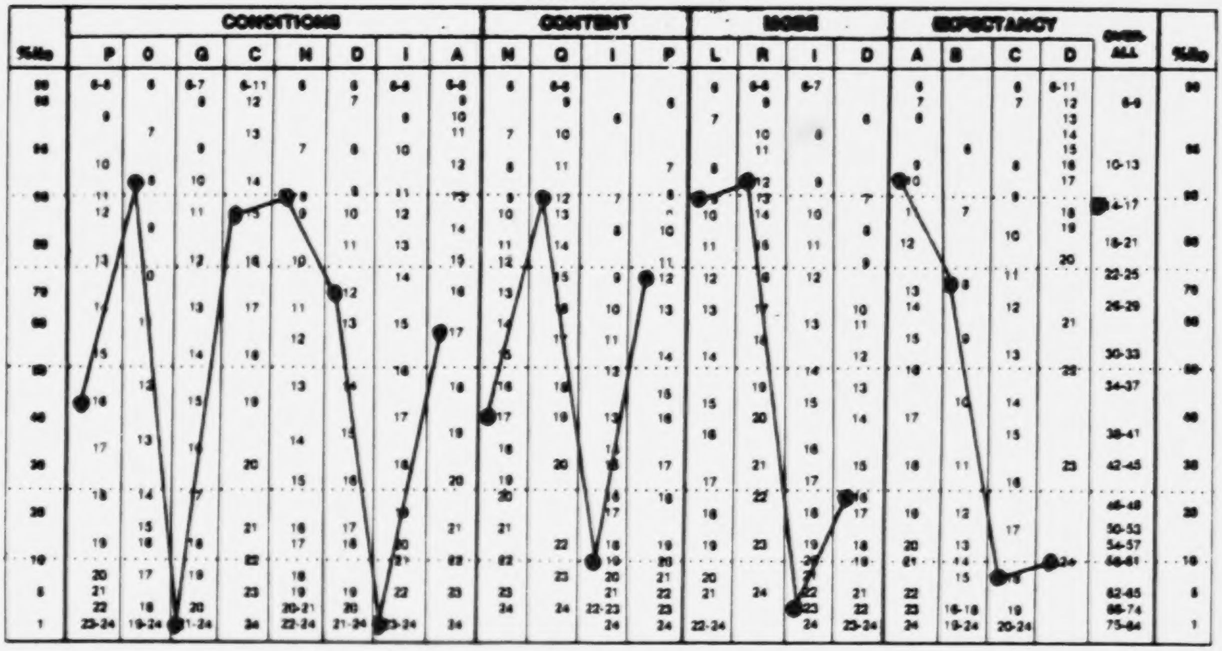
NAME Number Three Achievement Score 41

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Experimental Group AGE ____ SEX MALE

MALE ADULT (N = 1,364)



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# Learning Styles Inventory Percentile Profile

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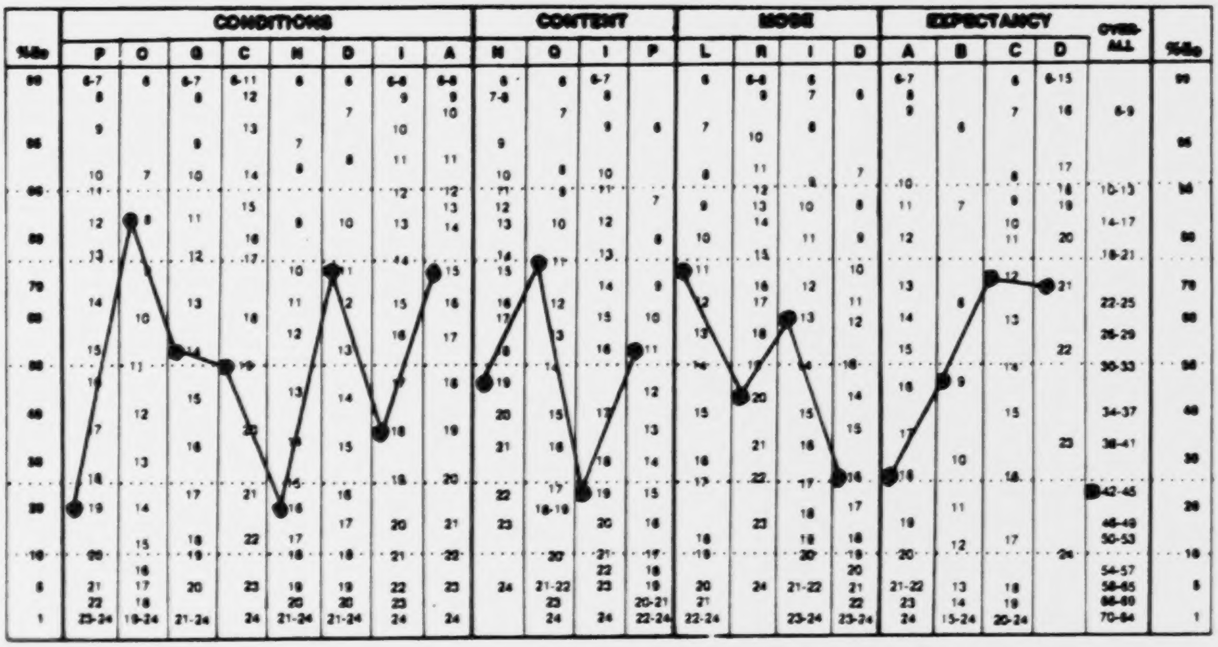
NAME Number Four Achievement Score 28
(Last) (First) (Mid Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Experimental Group AGE ______ SEX FEMALE
(Class Program etc.) (Male or Female)

FEMALE ADULT (N = 1,180)



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# Learning Styles Inventory Percentile Profile

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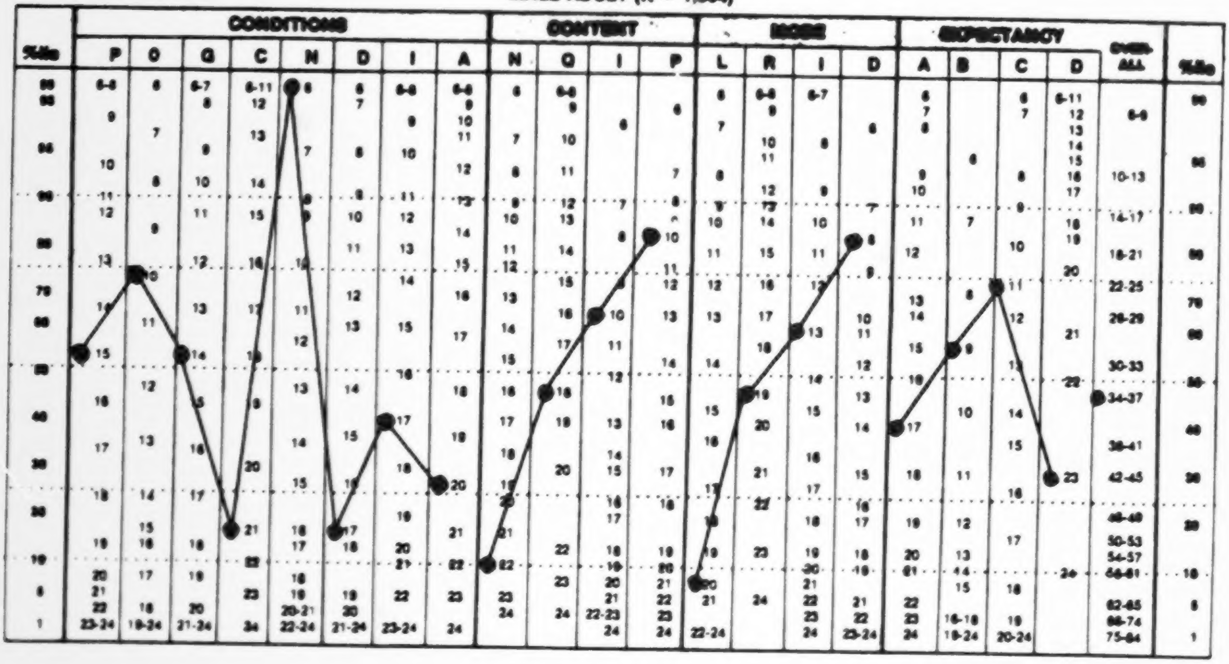
NAME Number Five Achievement Score 14
(Last) (First) (Mid Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Experimental Group AGE ______ SEX MALE
(Class, Program, etc.) (Male or Female)

MALE ADULT (N = 1,384)



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# Learning Styles Inventory Percentile Profile

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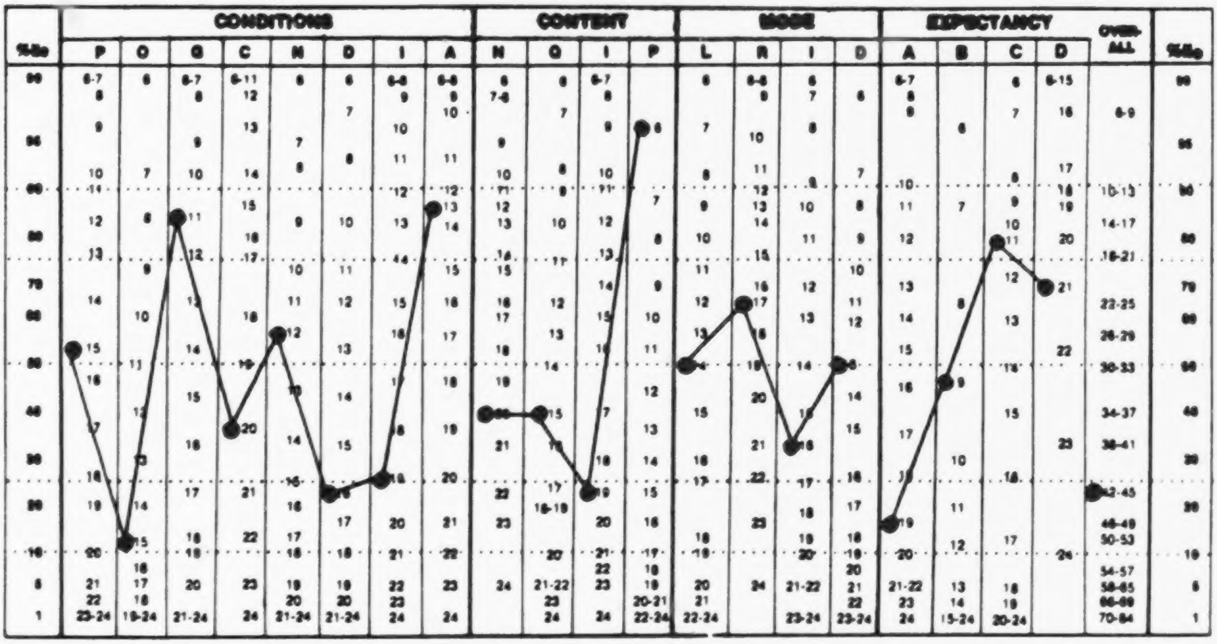
NAME Number Six Achievement Score 36
(Last) (First) (Mid Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Experimental Group AGE ______ SEX FEMALE
(Class Program etc.) (Male or Female)

FEMALE ADULT (N = 1,180)



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# Learning Styles Inventory Percentile Profile

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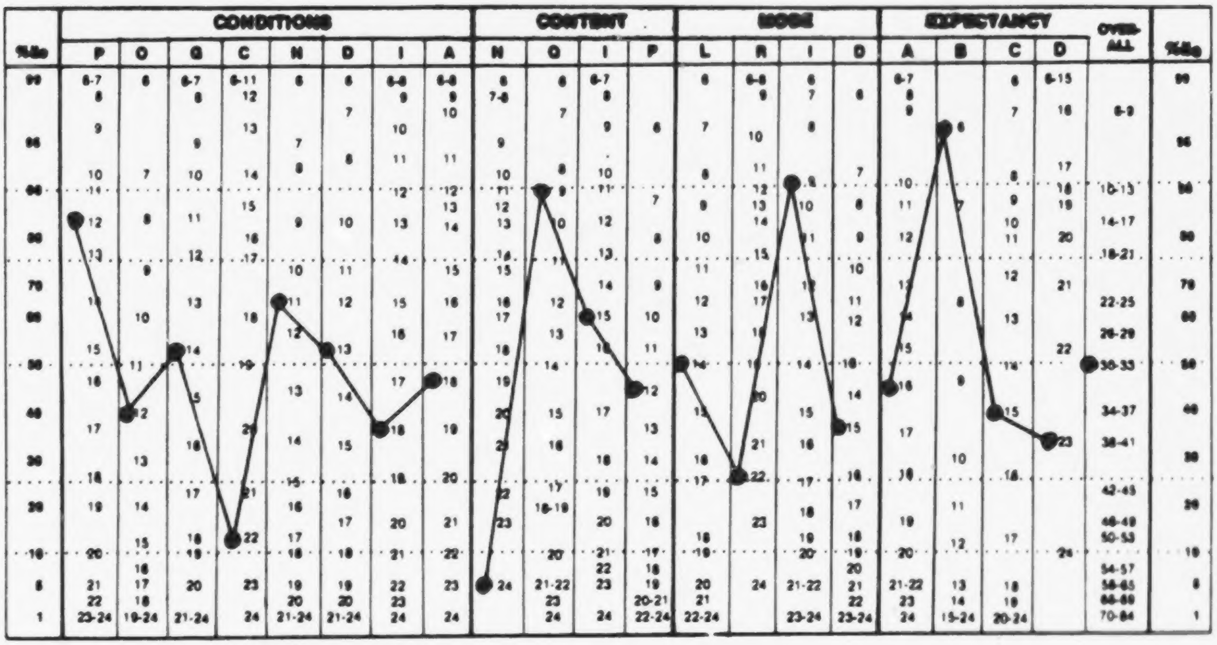
NAME Number Seven (Last) Achievement Score 24 (First) (Mid Initial)

INSTITUTION/SCHOOL Eastern New Mexico University DATE January 14, 1981

CLASS/GROUP Experimental Group (Class Program etc.) AGE ______ SEX FEMALE (Male or Female)

FEMALE ADULT (N = 1,180)



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